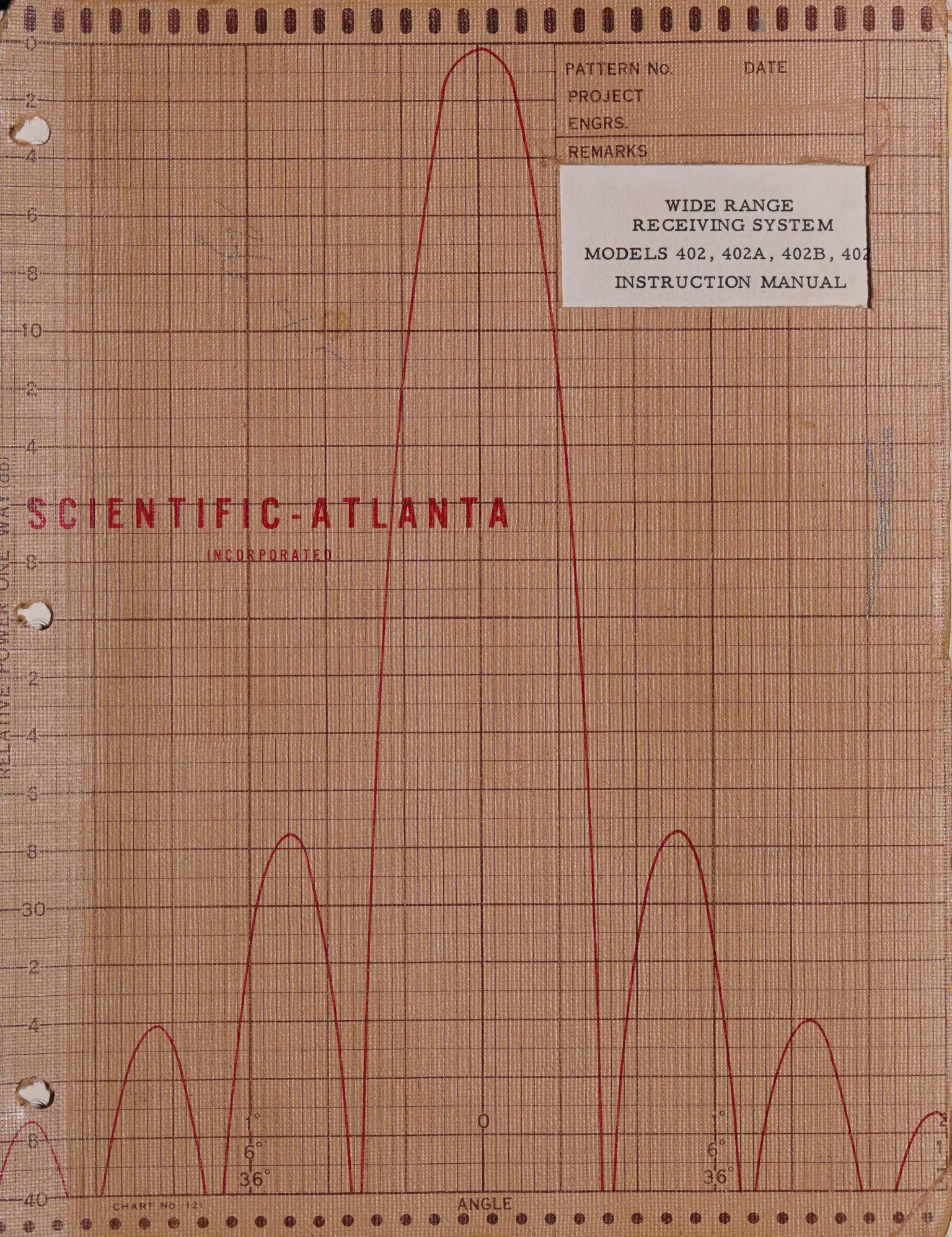
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WIDE RANGE
RECEIVING SYSTEM
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INSTRUCTION MANUAL
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RETURN TO
ENGINEERING LABORATORY

DOUGLAS AIRCRAFT CO., INC.
EL SEGUNDO DIVISION

WIDE RANGE RECEIVING SYSTEM
MODELS 402, 402A, 402B, 402C
INSTRUCTION MANUAL

Model 402C-60, S/N 29
QKB 691 S/N 1583
Anode Volts 140

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WARNING

The cabinet of the Wide Range Receiving System should be grounded to prevent static charges from the high voltage power supply from accumulating on the cabinet.

As is the case for all high voltage equipment, the Wide Range Receiving System should not be operated with other equipment from a common ungrounded power line. The other low voltage equipments may be placed at a high potential should a primary to secondary short develop in the high voltage transformer of the Wide Range Receiving System when the common power line connection is isolated from ground.

I. GENERAL DESCRIPTION

1.1 Introduction

Scientific-Atlanta, Inc., Series 402 Wide Range Receiving Systems are superheterodyne type receivers designed specifically to provide wide frequency coverage, high sensitivity, and good linearity. The receiver input over the entire frequency range is provided by a 15-foot length of either RG-55/U or RG-5A/U coaxial cable. The receivers will operate from either a cw signal source or a square-wave modulated signal source. During operation of the Model 402A or 402C receivers, receiver gain compensation for signal power variations of ± 2 db is provided by an agc circuit which monitors the transmitted power.

The receivers provide a bolometer output for the operation of antenna pattern recording equipment. A full 40 db receiver dynamic range is obtained with a linear deviation of less than 1 db over the full 40 db range. See Figure 1. An afc circuit provides frequency locking of the local oscillator with the received signal over the full receiver dynamic range. In addition, an afc null meter, located on the receiver control panel provides a continuous indication of the frequency drift of the received signal.

1.2 Specifications

Receiver Type	Superheterodyne
Frequency Coverage	Models 402 and 402A - 2 kmc to 75 kmc Models 402B and 402C - 30 mc to 75 kmc
Input Signals	CW or square-wave modulated signals (Modulation frequencies 900 cps or 1100 cps)
Dynamic Range	40 db
Linear Deviation of Output	Less than 1 db
IF Bandwidth	1 mc
IF Frequency	65 mc

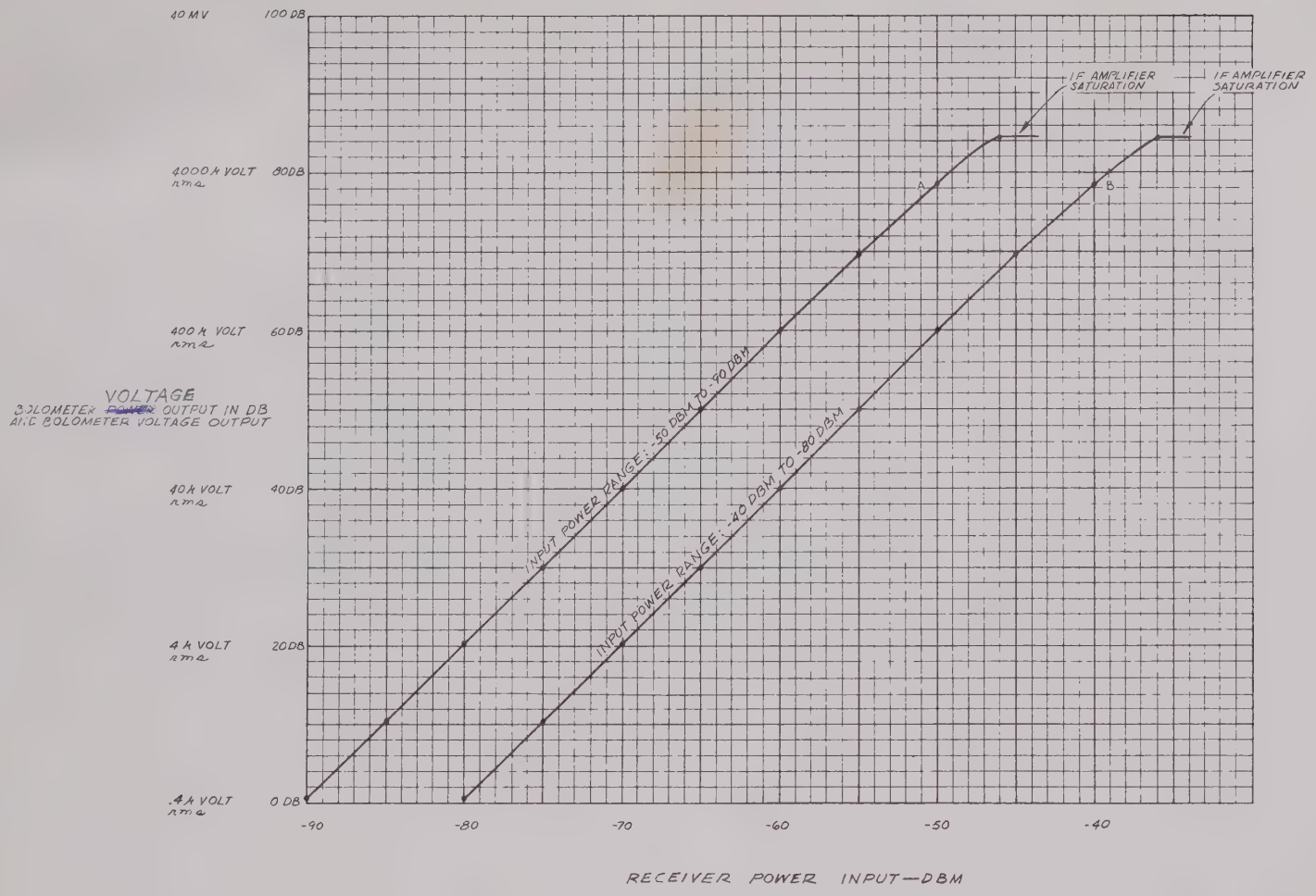

Figure No. 1

Wide Range Receiving System Linearity Curves

Sensitivity Attainable	
30 mc to 500 mc	-90 dbm (Models 402B and 402C only)
500 mc to 2 kmc	-85 dbm (Models 402B and 402C only)
2 kmc to 10 kmc	-85 dbm
10 kmc to 35 kmc	-80 dbm
35 kmc to 75 kmc	-65 dbm
Recorder Detector	Bolometer
AFC Detector	Germanium Diode
Tuning	Electronic
Frequency Accuracy	± 5%
AFC Dynamic Range	45 db
AGC Minimum Input Signal	100 uv (Models 402A and 402C only)
AGC Control Range	± 2 db (Models 402A and 402C only)
AGC Correction	Within ± 1/2 db (Models 402A and 402C only)
RF Input Impedance	50 ohms
Power Requirements	115 v, 50/60 cps, 800 watts
Size	59-5/8" high, 22" deep, 23-1/2" wide
Weight	330 pounds

1.3 Principles of Operation

A block diagram of the Wide Range Receiving System is shown by Figure 2. The extremely broad tuning range of the receiver is obtained by the use of two separate rf systems, shown dotted in Figure 2. The tunable local oscillator, used with both rf systems, is a Raytheon type QK518 backward-wave oscillator or carcinotron. This tube is voltage tunable over a frequency range of from 2000 to 4000 mc with a power output of 250 mw or more. For Models 402B and 402C a carcinotron is selected which tunes over a frequency range from 2030 mc to 4100 mc. A 1000 cps modulation is added to the received signal by sweeping the carcinotron voltage-tunable delay line with a 1000 cps sawtooth voltage of sufficient amplitude to frequency modulate the local oscillator over a range of several megacycles.

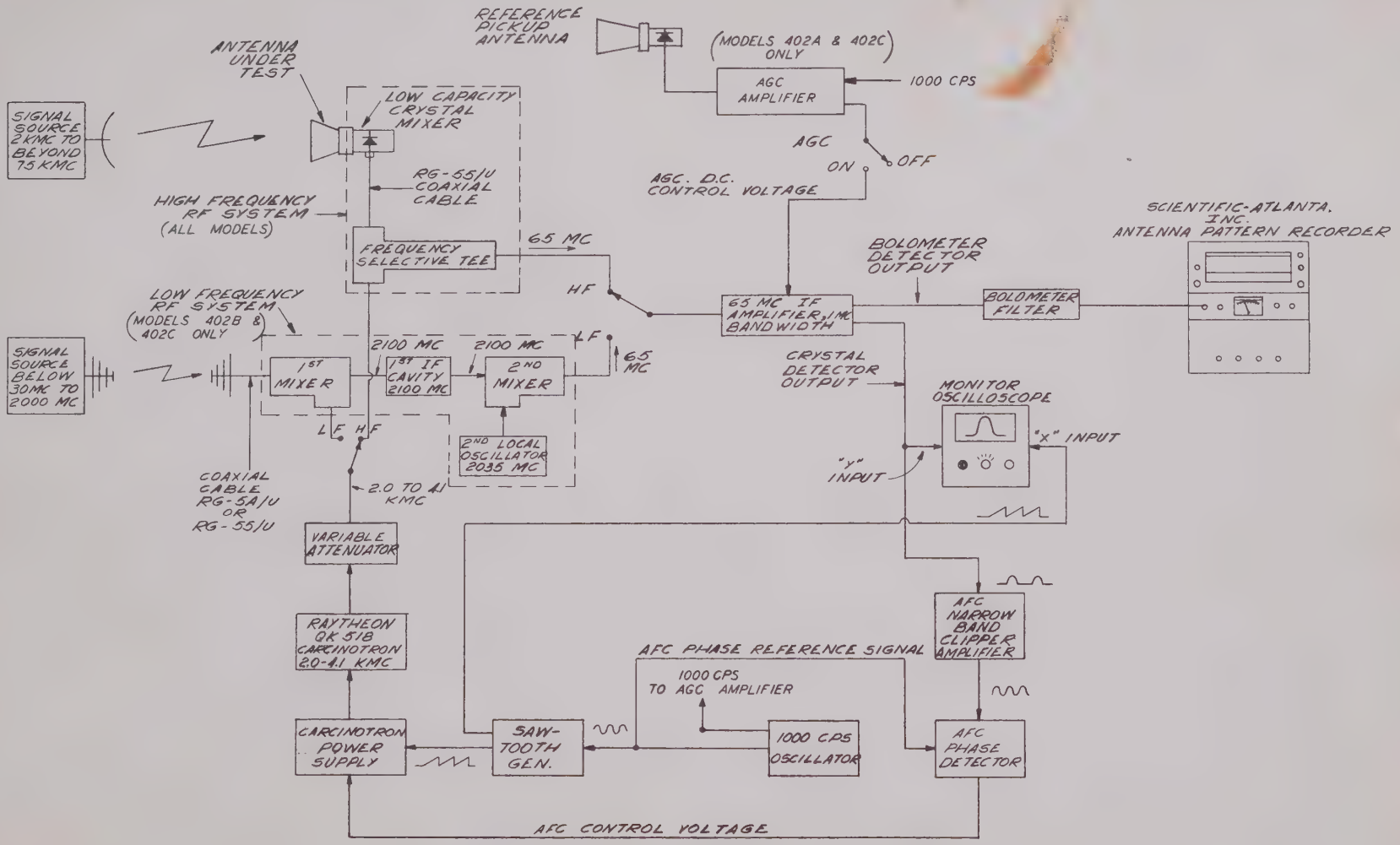

Figure No. 2

Block Diagram of the Wide Range Receiving System

During operation of the receiver from 2 to 75 kmc (all models), the carcinotron output is fed through an adjustable attenuator to the local oscillator arm of a frequency-selective tee. This tee couples the local oscillator signal to the RG-55/U cable which in turn couples the receiver to an appropriate crystal mount located at the terminal of the receiving antenna. The capacity of the crystal holder should be small to obtain a minimum vswr on the coaxial transmission line.

The CARCINOTRON OUTPUT ATTENUATOR is adjusted to provide sufficient crystal current to furnish the crystal detector the necessary fundamental or harmonic local oscillator power required for mixing. The crystal current normally falls in the region between 0.5 and 4 ma with the higher crystal currents required to generate the higher order harmonics. The receiver utilizes harmonics of the carcinotron output as high as the 18th. The carcinotron delay line voltage required to tune the receiver to a specific frequency can be determined to within ± 5% by referring to the WIDE RANGE RECEIVER TUNING CHART (Figure 3). The carcinotron delay line voltage is metered for the purpose of tuning. The carcinotron is tuned to obtain a 65 mc difference signal between the local oscillator fundamental or harmonic and the received signal. Normally, reception can be obtained at two local oscillator frequencies spaced 130 mc apart, either of which may be used. The 65 mc if signal is coupled by the 15-foot RG-55/U coaxial cable from the crystal mount to the frequency-selective tee through which it is channeled to the if amplifier.

The low frequency rf system (Models 402B and 402C only) employs double conversion to permit reception in the frequency range of from 30 to 2000 mc while using the carcinotron as the tunable local oscillator. The low frequency antenna is coupled through a 50-ohm RG-5A/U or RG-55/U coaxial cable to the first-mixer signal input connector. The carcinotron output is fed through the variable attenuator into the local oscillator input of the first mixer. A signal in the frequency range of from 30 mc to 2000 mc fed into the first mixer is converted to a 2100 mc first if signal by tuning the

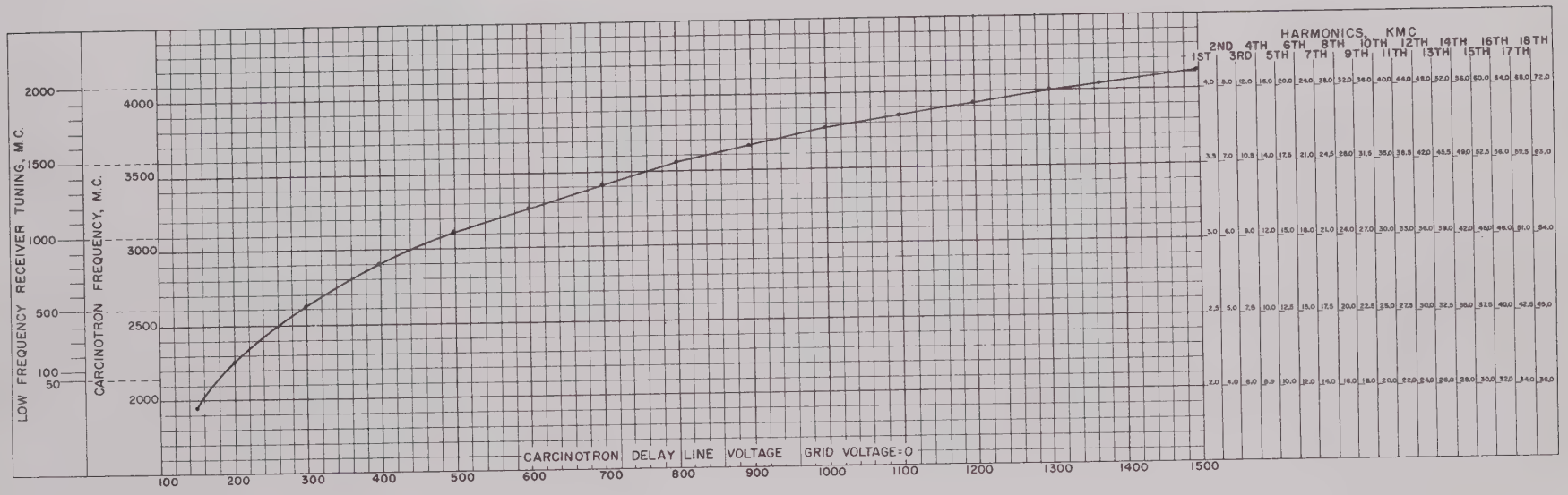

Figure No. 3

Wide Range Receiver Tuning Chart

carcinotron to a frequency 2100 mc higher than the received signal. The 2100 mc high "Q" cavity, located between the first-mixer output and the second-mixer input, provides the first if selectivity. The 2035 mc second local oscillator signal is fed into the second mixer and permits conversion of the 2100 mc first if signal into a 65 mc second if signal, which is fed to the if amplifier.

The if amplifier is a synchronous single-tuned amplifier with a half-power bandwidth of 1 mc. The frequency modulation of the carcinotron output, obtained by the sawtooth voltage applied to the delay line, causes an if signal, developed from a cw receiver input signal, to be swept across the pass band of the if amplifier. This action results in an if amplifier signal output with an envelope representing the bandpass characteristics of the if amplifier. The if amplifier bandpass characteristic is so shaped that the envelope of the output signal, when displayed on the monitor oscilloscope, has the general appearance of a half-loop sine wave.

Two separate if amplifier video outputs are provided. The first, a linear output derived from a crystal detector, is fed to the vertical deflection amplifier of the monitor oscilloscope and to the afc amplifier. The second is derived from a square-law bolometer detector and is coupled through a 1000 cps bandpass filter to the output connector for the antenna pattern recorder.

The receiver includes an afc system which compares the phase of the 1000 cps if amplifier output envelope with that of the sweep voltage applied to the carcinotron delay line. The afc phase detector develops an error voltage proportional to the magnitude and direction of displacement of the crest of the if amplifier output waveform with respect to the center of the sawtooth sweep voltage. This error voltage controls the carcinotron delay line voltage in such a manner as to oppose a phase displacement. This results in an automatic shift of the carcinotron frequency to compensate for a change in the received signal frequency. By the use of a narrowband limiting afc amplifier, stable afc operation is obtained over a dynamic signal range of 45 db or more.

To permit the receiving system to compensate for small transmitter power fluctuations, an agc amplifier is employed (Models 402A and 402C only). This amplifier employs a phase-sensitive detector synchronized with the 1000 cps receiver sweep and provides an agc control voltage proportional to the agc amplifier input signal. The input signals for this amplifier are obtained from a crystal holder which detects a sample of the transmitted power. This sample may be taken at the transmitter or from a reference antenna if sufficient power is available. The agc amplifier input signal level must be 100 uv or greater.

The agc control voltage output furnished by the agc amplifier is applied as a gain control voltage to one stage of the if amplifier and varies the receiver gain inversely as the variation of the transmitted power. The effect of this agc action is to maintain the if amplifier output voltage constant to within ± 1/2 db for a signal power variation of ± 2 db.

To receive a square-wave modulated signal, the receiving system is operated as for cw signal reception; however, the modulation frequency of the transmitter is adjusted such that the beat frequency between the 1000 cps receiver sweep and the square-wave modulation is above the range of response of the antenna pattern recorder. Both the afc and the agc systems will operate under this condition.

II. OPERATING INSTRUCTIONS

2.1 CW or Square-Wave Modulated Signal Reception (2 to 75 kmc)(All Models)

A. Switch Positions and Cable Connections: Models 402A and 402C: Place the AGC switch in the OFF position.

Models 402B and 402C: Turn the SECOND LOCAL OSCILLATOR switch OFF. Connect the CARCINOTRON OUTPUT connector on the RF Unit to the HIGH FREQUENCY MIXER INPUT by the short cable supplied. Connect the IF AMPLIFIER INPUT to the HIGH FREQUENCY MIXER IF OUTPUT with the other short cable supplied.

All models: Turn the CARCINOTRON OUTPUT ATTENUATOR fully clockwise (maximum attenuation). Set the MIXER CRYSTAL POLARITY switch to the polarity corresponding to the crystal being used. Connect one end of the 15-foot RG-55/U cable to the HIGH FREQUENCY RECEIVER INPUT and the other end to the microwave crystal holder to be used at the antenna terminal. If available, a General Radio (No. 874) line stretcher may be placed in series with the 15-foot RG-55/U cable.

Connect the output of the receiver (TO BOLO AMP) to the INPUT connector of the Scientific-Atlanta Pattern Recorder Crystal-Bolometer Amplifier. Adjust the bolometer current to 6 milliamperes. Turn the pattern recorder PEN MOTOR OFF.

The receiver should be connected to a 115-volt, 60-cycle outlet capable of providing 800 watts. The receiver should be grounded using the ground lug provided. It is recommended that the recorder case be grounded to the receiver. ~~through the bolometer cable only. This prevents ground loop currents from flowing in this cable which cause excessive jitter of the recorder pen at low signal levels~~. The power line feeding the antenna pattern recorder should not be isolated from the power line feeding the receiver.

B. Tuning: Turn the LOW VOLTAGE switch ON. A thermal time delay relay will close after approximately one minute. If the HIGH VOLTAGE switch is OFF, the READY light will come on, if the HIGH VOLTAGE switch is ON, the high-voltage relay will close and delay line voltage will be indicated on the CARCINOTRON DELAY LINE VOLTAGE meter.

Refer to the TUNING CHART to find the approximate carcinotron delay line voltage for the desired frequency of reception and set the CARCINOTRON TUNING RANGE switch and the CARCINOTRON TUNING control for this approximate reading on the CARCINOTRON DELAY LINE VOLTAGE meter. The carcinotron tuning chart calibration will vary with various carcinotrons but should not exceed a 5% deviation.

Adjust the CARCINOTRON GRID BIAS control for a maximum carcinotron delay line current but not in excess of 40 ma. Turn the CARCINOTRON OUTPUT ATTENUATOR counterclockwise (minimum attenuation) until a crystal current of approximately 1 ma is indicated.

Increase the RECEIVER GAIN control and/or the monitor oscilloscope gain control (V GAIN) until receiver noise is visible on the oscilloscope. Turn the CARCINOTRON FREQUENCY MODULATION control fully clockwise to give maximum carcinotron frequency modulation.

Adjust the CARCINOTRON TUNING control until a received signal is observed. Normally, two signal indications spaced in frequency by twice the if frequency, 130 megacycles, will appear. Either signal may be used. Attenuate the input signal until a signal-to-noise ratio of approximately 2 to 1 is obtained. Maximize the signal-to-noise ratio by adjusting the CARCINOTRON OUTPUT ATTENUATOR and the line stretcher, if used. Do not allow the crystal current to exceed 5 ma, as excessive current may damage the crystal and give excessive noise. The optimum value of crystal current is highest at Q-band, about 4 ma. The normal optimum crystal current at X-band is 1 ma and from 0.5 to 1 ma at lower frequencies.

After the signal-to-noise ratio has been optimized, increase the rf input signal to provide a signal-to-noise ratio of 10 to 1 or better. Turn the antenna pattern recorder PEN MOTOR ON and adjust the CARCINOTRON SWEEP FREQUENCY and the CARCINOTRON FREQUENCY MODULATION controls for maximum pen deflection.* The recorder audio frequency should be 1000 cps ± 2%. Turn the antenna pattern recorder PEN MOTOR OFF.

C. AFC Adjustment: Turn the AFC GAIN control fully counter-clockwise and the AFC switch ON. Adjust the CARCINOTRON TUNING control to center the signal on the oscilloscope sweep. Adjust the CARCINOTRON SWEEP PHASE control for a zero indication on the AFC NULL meter. Turn the AFC GAIN control clockwise as far as possible without the signal oscillating. The signal should now be locked on the oscilloscope sweep by the afc circuit. If the signal is thrown off the sweep by the afc, rotate the CARCINOTRON SWEEP PHASE control for a new afc null. This shifts the afc phase by 180 degress and provides afc locking.

With the afc adjusted, turn the AFC switch OFF and detune the signal to one side of the sweep by varying the CARCINOTRON TUNING control. The signal should return to the center of the sweep without bouncing when the AFC switch is turned ON again. Adjust the AFC GAIN control for good signal lock-in without excessive bouncing. After setting the AFC GAIN control, reset the CARCINOTRON TUNING control for a zero reading of the AFC NULL meter. A further deviation from a null appearing on this meter indicates a drift in the frequency of the received signal. If the drift becomes excessive, readjust the carcinotron tuning. This will assure afc lock-in following a signal interruption.

* Square-Wave Modulated Received Signals: When receiving a square-wave modulated signal, adjust the transmitter modulation frequency to a value either above or below 1000 cps such that the frequency of the beat between the square-wave modulation and the 1000 cps receiver sweep is above the range of frequency response of the antenna pattern recorder.

D. Gain Adjustment: The system is now ready to operate with the Scientific-Atlanta Antenna Pattern Recorder. The operating gain level should be carefully set to assure both maximum sensitivity and linearity. Adjust both the position of the antenna and the crystal-mixer tuning for a maximum signal indication. Increase the RECEIVER GAIN until the if amplifier saturates. Reduce the RECEIVER GAIN setting for a peak signal level approximately 0.7 of the saturation level. Set the gain of the bolometer crystal amplifier of the antenna pattern recorder for full-scale pen deflection at this signal level. It is advisable to use the lowest recorder sensitivity possible in order to minimize bolometer noise. Do not reduce the antenna pattern recorder sensitivity to a level that will require greater than 4000 microvolts rms output from the bolometer for full scale pen deflection since the bolometer output will deviate from square-law at high signal levels. If the power level of the received signal is below the level necessary to saturate the if amplifier, the RECEIVER GAIN control should be set to maximum gain.

The linearity of the receiver may be checked by observing the recorder pen setting for various settings of an rf attenuator preceding the crystal mixer. A useful 40 db range should be obtained.

2.2 CW or Square-Wave Modulated Signal Reception (30 mc to 2 kmc)(Models 402B and 402C)

A. Switch Positions and Cable Connections: Model 402C: Place the AGC switch in the OFF position.

Models 402B and 402C: Connect the CARCINOTRON OUTPUT connector on the RF Unit to the LOW FREQUENCY MIXER input. Connect the if amplifier INPUT connector to the LOW FREQUENCY MIXER IF OUTPUT. Set the MIXER CRYSTAL POLARITY switch to +.

Turn the CARCINOTRON OUTPUT ATTENUATOR fully counterclockwise (minimum attenuation). Turn the SECOND LOCAL OSCILLATOR switch ON. Connect one end of the 15-foot RG-5A/U cable to the antenna under test. The first-mixer crystal is located in the first mixer within the low frequency

receiver. If available, a General Radio (No. 874) line stretcher may be placed in series with the 15-foot RG-5A/U cable.

Connect the output of the receiver (TO BOLO AMP) to the INPUT connector of the Scientific-Atlanta Pattern Recorder Bolometer Crystal Amplifier. Adjust the bolometer current to 6 milliamperes. Turn the pattern recorder PEN MOTOR switch OFF.

The receiver should be connected to a 115-volt, 50/60-cycle outlet capable of providing 800 watts. The receiver should be grounded using the ground lug provided. It is recommended that the recorder case be grounded to the receiver. ~~through the bolometer cable only. This prevents ground loop currents from flowing in this cable which cause excessive jitter of the recorder pen at low signal levels~~. The power line feeding the antenna pattern recorder should not be isolated from the power line feeding the receiver.

B. Tuning: Turn the LOW VOLTAGE switch ON. A thermal time delay relay will close after approximately one minute. If the HIGH VOLTAGE switch is OFF, the READY light will come on, if the HIGH VOLTAGE switch is ON, the high-voltage relay will close and delay line voltage will be indicated on the CARCINOTRON DELAY LINE VOLTAGE meter.

Refer to the tuning chart to find the approximate carcinotron delay line voltage for the desired frequency of reception and set the CARCINOTRON TUNING RANGE switch and the CARCINOTRON TUNING control for this approximate reading on the CARCINOTRON DELAY LINE VOLTAGE meter. The carcinotron tuning chart calibration will vary with various carcinotrons but should not exceed a 5% deviation.

A second-mixer crystal current of from 1 to 2 ma should be observed on the CRYSTAL CURRENT meter. Adjust the CARCINOTRON GRID BIAS control for a maximum delay line current but not in excess of 40 milliamperes.

Adjust the RECEIVER GAIN control and/or the monitor oscilloscope gain control until receiver noise is visible on the oscilloscope. Turn the

CARCINOTRON FREQUENCY MODULATION control fully clockwise for a maximum carcinotron frequency modulation.

Adjust the CARCINOTRON TUNING control until a received signal is observed. Attenuate the input signal by means of an rf attenuator or by positioning the antenna until a signal-to-noise ratio of approximately 2 to 1 is observed. Maximize the signal-to-noise ratio by adjusting the CARCINOTRON OUTPUT ATTENUATOR. This position may be fully counterclockwise. Adjust the line stretcher, if used, for a maximum signal-to-noise ratio.

After the signal-to-noise ratio has been optimized, increase the rf input signal to provide a signal-to-noise ratio of 10 to 1 or better. Turn the antenna pattern recorder PEN MOTOR switch ON and adjust the CARCINOTRON SWEEP FREQUENCY and the CARCINOTRON FREQUENCY MODULATION controls for maximum pen deflection.* The recorder audio frequency should be 1000 cps ± 2%. Turn the antenna pattern recorder PEN MOTOR switch OFF.

C. AFC Adjustment: Turn the AFC GAIN control fully counterclockwise and the AFC switch ON. Adjust the CARCINOTRON TUNING control to center the signal on the oscilloscope sweep. Adjust the CARCINOTRON SWEEP PHASE control for a zero indication on the AFC NULL meter. Turn the AFC GAIN control clockwise as far as possible without the signal oscillating. The signal should now be locked on the oscilloscope sweep by the afc circuit. If the signal is thrown off the sweep by the afc circuit, rotate the CARCINOTRON SWEEP PHASE control for a new afc null. This shifts the afc phase by 180 degrees and provides afc locking.

* Square-Wave Modulated Received Signals: When receiving a square-wave modulated signal, adjust the transmitter modulation frequency to a value either above or below 1000 cps such that the frequency of the beat between the square-wave modulation and the 1000 cps receiver sweep is above the range of frequency response of the antenna pattern recorder.

With the afc adjusted, turn the AFC switch OFF and detune the signal to one side of the sweep by varying the CARCINOTRON TUNING control. The signal should return to the center of the sweep without bouncing when the AFC switch is turned ON again. Adjust the AFC GAIN control for good signal lock-in without excessive bouncing. After setting the AFC GAIN control, reset the CARCINOTRON TUNING control for a zero reading of the AFC NULL meter. A further deviation from a null appearing on this meter indicates a drift in the frequency of the received signal. If the drift becomes excessive, readjust the carcinotron tuning. This will assure afc lock-in following a signal interruption.

D. Gain Adjustment: The system is now ready to operate with the Scientific-Atlanta Antenna Pattern Recorder. The operating gain levels should be carefully set to assure both maximum sensitivity and linearity. Adjust both the position of the antenna and the crystal mixer tuning for a maximum signal indication. Increase the receiver gain until the if amplifier saturates. Reduce the RECEIVER GAIN setting for a peak signal level approximately 0.7 of the saturation level. Set the gain of the bolometer amplifier of the antenna pattern recorder for full-scale pen deflection with this signal level. It is advisable to use the lowest recorder sensitivity possible in order to minimize bolometer noise. Do not reduce the antenna pattern recorder sensitivity to a level that will require greater than 4000 microvolts rms output from the bolometer for full scale pen deflection since the bolometer output will deviate from square-law at high signal levels. If the power level of the received signal is below the level necessary to saturate the if amplifier, the RECEIVER GAIN control should be set for maximum gain.

The linearity of the receiver may be checked by observing the recorder pen setting for various settings of an rf attenuator placed in series with the input cable. A useful 40 db range should be obtained.

2.3 AGC Operation (Models 402A and 402C)

The Models 402A and 402C Wide Range Receiving Systems are each provided with an agc amplifier which permits automatic receiver gain compensation for small variations in the transmitter power.

A. Transmitter Sample: A sample of the cw or square-wave modulated transmitter signal must be obtained to operate the agc amplifier. This sample should furnish a signal level of 100 uv or greater to the agc input and may be obtained at the transmitter or from a reference antenna located at the receiver. A crystal detector (crystal holder) must be coupled to the sample source and the detector output jack coupled by a length of RG-62/U coaxial cable to the agc amplifier INPUT connector.

B. AGC Adjustment: Follow the operation procedure as outlined in Section 2.1 or Section 2.2 for the desired frequency of reception. Set the AGC CRYSTAL POLARITY switch to conform to the agc crystal detector polarity. Set the agc ATTENUATOR and GAIN controls for an agc signal level at the SET POINT on the AGC METER.

This reading will be stable if sufficient input power is available. The gain of the receiver will be modified slightly and the receiver will automatically compensate for transmitter power variations of ±2 db. The antenna pattern recorder gain may be reset, if desired, to obtain a full scale pen reading for a maximum received signal.

The AGC SLOPE, +DB and -DB controls (located on the IF Amplifier and Power Supply chassis) modify the slope of the agc output voltage to provide proper receiver gain compensation. If adjustment is required, (1) decrease the transmitter power 2 db and adjust the AGC SLOPE, -DB control to obtain a receiver output signal with less than a 1/2 db decrease, (2) increase the transmitter power 2 db and adjust the AGC, SLOPE, +DB control to obtain a receiver output signal with less than a 1/2 db increase, (3) vary the transmitter power slowly ±2 db. The receiver output signal should vary less than ±1/2 db. Repeat steps 1 and 2 as required.

III. DETAILED DESCRIPTION

3.1 Physical Description

The Wide Range Receiving System Series 402 is composed of six individual rack mounting units. The front panel of each unit is 19 inches wide and the total panel height occupied by the six units is 52-1/2 inches. These units are normally mounted in a standard 19-inch rack cabinet with outside dimensions of 59-5/8 inches high, 22 inches deep, and 23-1/2 inches wide. To provide front accessibility for maintenance and testing, the five larger units are mounted on rack slides. Rear access to the units and cables is provided by a full length rear door which may be locked. Drawing No. 1 is a rear view showing the physical layout and the cabling of the system. In special cases the system may be mounted in a console.

Cooling of the receiving system is accomplished by an exhaust fan mounted in the top of the rack. An air intake filter is located on the front panel of the Carcinotron Power Supply. A blower for the carcinotron is located beneath the shielded carcinotron enclosure.

3.2 Control Unit

The Control Unit (Drawing No. 2) provides centralization of the controls and meters necessary for adjusting and monitoring the receiving system. The circuits on this chassis are arranged to provide accessibility for maintenance and testing.

A. Internal Oscillator and Associated Circuits: The internal oscillator V1-1 (6AN8) is a lamp-bridge oscillator which generates a 90-volt peak-to-peak sine wave for the purpose of establishing a reference frequency for the local oscillator sweep circuit and the afc circuit.

The frequency of the oscillator (950 cps to 1050 cps) is set by the CARCINOTRON SWEEP FREQUENCY control, R1-1. The level of the

output voltage (90 volts peak-to-peak measured between ground and pin 3 of V1-1) is set by the OSCILLATOR FEEDBACK control, R4-1. The oscillator output is coupled to the grids of both halves of V3-1. The first half of V3-1 is a cathode follower with the primary of T2-1 acting as the cathode load. The secondary of T2-1 furnishes a phase reference signal to the afc phase detector. This output is a center tapped, 220 volt peak-to-peak sine wave.

The second half of V3-1 (5814A) and the first half of V4-1 (5814A) comprise an adjustable phase shifter which provides a 300° phase displacement of the 1000 cps signal. This phase adjustable signal is applied to a symmetrical cathode coupled clipper V5-1 (5814A) which provides a 60-volt peak-to-peak square-wave output. This output is coupled through the cathode follower, one half of V4-1, to the differentiating circuit C16-1 and R35-1. The positive pulses appearing across R35-1 trigger the sawtooth generator V6-1 (2D21). The first half of V7-1 (12BH7A) provides bootstrap action for the sawtooth generator. The sawtooth voltage from V6-1 is coupled to the CARCINOTRON FREQUENCY MODULATION control, R48-1. This sawtooth voltage is attenuated by the voltage divider R42-1, R43-1 and R108-1 and is coupled to the monitor oscilloscope as the horizontal sweep voltage.

The output of CARCINOTRON FREQUENCY MODULATION control is coupled to a cathode follower, the second half of V7-1. The secondary impedance of T5-1, located in the cathode circuit of V7-1 is less than 50 ohms and the available peak sawtooth voltage across the secondary is 13 volts. The secondary of T5-1 is in series with the carcinotron delay line ground and the carcinotron power supply common and provides frequency modulation of the carcinotron.

B. AFC Circuit: The input for the afc amplifier circuit is obtained from the crystal detector output of the if amplifier. The input waveform is the 1000 cps swept if amplifier bandpass characteristic curve having an amplitude between if amplifier saturation and the if amplifier noise level. The afc amplifier input circuit is a high gain selective stage comprised of V8-1

(6AG5) and the tuned circuit L2-1 and C24-1. This selective stage removes the harmonic components from the input signal and furnishes a 1000 cps sine wave to the grid of V9-1. V9-1, V10-1, and V11-1 (6201's) are cathode coupled clipper stages which symmetrically limit the 1000 cps signal and provide a signal output with a constant amplitude over a dynamic range of input signals of greater than 50 db. The final cathode coupled clipper plate circuit contains a 1000 cps high "Q" tuned circuit which provides a sine wave output. This output is coupled to the grid of the amplifier V12-1 (6C4).

A transformer, T6-1, in the plate circuit of V12-1 couples the 1000 cps sine wave to the afc phase detector. The phase detector compares the phase of this signal with the phase reference signal obtained from the output of V3-1. The output of the phase detector is a dc voltage and appears across the AFC GAIN control potentiometer R95-1. For a 90° phase relationship between the phase signal and the phase reference voltage, the phase detector output is zero and for a 0° or 180° phase relationship, the output is either ± 30 v dc. The output voltage, metered by the AFC NULL meter, M1-1, is coupled through J5-1 and J2-6 to the carcinotron power supply differential amplifier V16-6 (6SU7).

The AFC ON-OFF switch, S2-1, in the OFF position, removes the 1000 cps sine wave signal from the grid of V12-1. This provides zero phase detector output voltage and permits the METER BALANCE potentiometer, R92-1, to be adjusted for a zero AFC NULL meter reading. With this switch OFF, the receiver is operating without afc.

C. Carcinotron Power Supply Control and Metering Circuit: The CARCINOTRON TUNING control (R98-1), the CARCINOTRON GRID BIAS control (R101-1), the CARCINOTRON TUNING RANGE switch (S3-1), the CARCINOTRON DELAY LINE VOLTAGE and CURRENT meters (M2-1 and M3-1), and the carcinotron power supply voltage regulator tubes, V13-1 through V26-1, are located on the Control Unit to provide centralization of controls and meters. All cables and hardware associated with the high voltage circuitry (1500 v dc) are provided with high voltage insulation. A detailed description of the operation of these circuits is given in Section 3.7.

D. Monitor Oscilloscope: The oscilloscope (Drawing No. 3) is a Waterman type P1 basic Panelscope to which vertical and horizontal deflection amplifiers have been added.

The vertical amplifier consists of two R-C coupled amplifier stages (V1-8, 12AY7), followed by a phase-splitting differential amplifier (V2-8, 12AY7) whose plates are connected directly to the deflection electrodes of the CRT V3-8 (3SP1). The first grid of V2-8 is clamped by diode CR1-8 to minimize shift of the sweep base-line in the presence of a signal blip. This grid is returned to a potential of plus 58 volts at the junction of R22-8 and R23-8. The voltage at the second grid is varied between 56 and 60 volts by the VERTICAL POSITIONING control, R21-8.

Two provisions are made which enable the vertical amplifier to handle overload signals without excessive charging of the coupling condensers so that small signals are not obscured by adjacent large signals which produce off-screen deflection. First, the plates of V1-8 are operated at low voltages (about 35 volts) so that clipping occurs on overload signals, limiting the maximum voltage excursions applied to the following grids. Second, the voltage at the plate of the first section of V2-8 is limited on negative excursions to a minimum value of about 150 volts by diode CR2-8 so that the cathode can follow the grid on overload signals; consequently, no grid current flows to charge C3-8.

The horizontal deflection amplifier (V4-8, 12AY7) is essentially identical to the final stage of the vertical amplifer, except that it has no clamping circuits.

An internal screwdriver-adjustable ASTIGMATISM control (R12-8) permits setting of the CRT anode potential for optimum operation of the FOCUS control (R16-8), such that the horizontal and vertical dimensions of the spot are minimized simultaneously. This control is accessible from the top of the chassis and is located between V5-8 and V2-8.

E. Receiver Gain Control: The RECEIVER GAIN control (R103-1) provides for the control of the if amplifier gain over a range greater than 40 db. This control varies the grid bias applied to the if amplifier from -5.5 volts at the counterclockwise position to -1 volts at the clockwise position.

3.3 AGC Amplifier

The AGC Amplifier (Models 402A and 402C only) uses the output of a crystal detector, monitoring the transmitted signal at a level of 100 uv or greater, to control the gain of the receiver IF Amplifier and compensate for transmitter power variations of ± 2 db. The AGC Amplifier will operate satisfactorily with an input signal level of -35 dbm at X-band and lower frequencies, provided that excessive thermoelectric and electrochemical potentials are not encountered in the external circuit.

The unit is constructed in two shielded compartments. One contains a chopper-drive frequency divider and amplifier; the other, an agc signal-voltage amplifier (Drawing No. 4).

The signal-voltage amplifier consists of a modulator (the armature and one contact of chopper K1-2), a four-stage R-C coupled amplifier (V1-2, 12AY7 and V2-2, 12AT7), and a synchronous rectifier (the armature and the other contact of K1-2). The chopper modulates the small dc signal from the crystal detector by periodically grounding the junction of R1-2 and R2-2. The resultant square wave is amplified by the high-gain ac amplifier and capacity-coupled to the primary of the output transformer T1-2. The correct phase of the amplified signal, determined by the crystal polarity and crystal holder arrangement, is selected by S2-2. The chopper rectifies the signal by periodically completing the circuit from one end of the secondary of T1-2 to ground. The rectified voltage is smoothed by an R-C filter.

The AGC LEVEL SET meter, M1-2, indicates the magnitude of the output voltage, which varies directly as the magnitude of the power of the signal received at the reference antenna. This output voltage is fed to the grid of V6-3 (6CB6) in the IF Amplifier chassis, providing gain compensation. With a gain control voltage of -2.5 volts at the agc set point, a

decrease in monitored signal level of 2 db reduces the agc output voltage to approximately -1.6 volts. R60-3 (AGC SLOPE, -DB control) modifies the slope of this voltage decrease to permit the receiver gain to be increased by an amount sufficient to maintain the receiver output constant to within 0.5 db of the signal level at the set point. An increase in the monitored signal level of 2 db would normally increase the agc output voltage to -4 volts, causing an excessive decrease in receiver gain. To eliminate this overcompensation, diode CR2-3 in series with R59-3 (AGC SLOPE, +DB control) conducts for agc output voltage above -2.5 volts to that required for proper gain compensation.

The chopper-drive amplifier consists of tubes V3-2 (6AW8) and V4-2 (12AT7). A 1000-cycle sine wave of six to eight volts rms amplitude, supplied by the internal oscillator of the Control Unit, is squared by the triode section of V3-2. The resultant waveform is differentiated by C17-2 and R30-2 to produce trigger pulses. These pulses are applied through diodes CR1-2 and CR2-2 to the plates of V4-2, a conventional bistable multivibrator. A 500-cycle square wave at the second plate of V4-2 is amplified by the pentode section of V3-2, shaped by the network R42-2, C22-2, C23-2, and applied through output transformer T2-2 to the coil of K1-2.

A 0-10 ma CRYSTAL CURRENT meter, M2-2, is located on the AGC Amplifier panel. It monitors the crystal current of the second mixer when the receiving system is connected for low frequency reception and monitors the crystal current of the first mixer when the receiving system is connected for high frequency reception. A MIXER CRYSTAL POLARITY switch, S3-2, is provided to accommodate different mixer crystal polarities and crystal holder arrangements.

In Models 402 and 402B which do not contain the agc amplifier, the CRYSTAL CURRENT meter and the MIXER CRYSTAL POLARITY switch are mounted on a panel which replaces the agc amplifier front panel (See Drawing No. 5).

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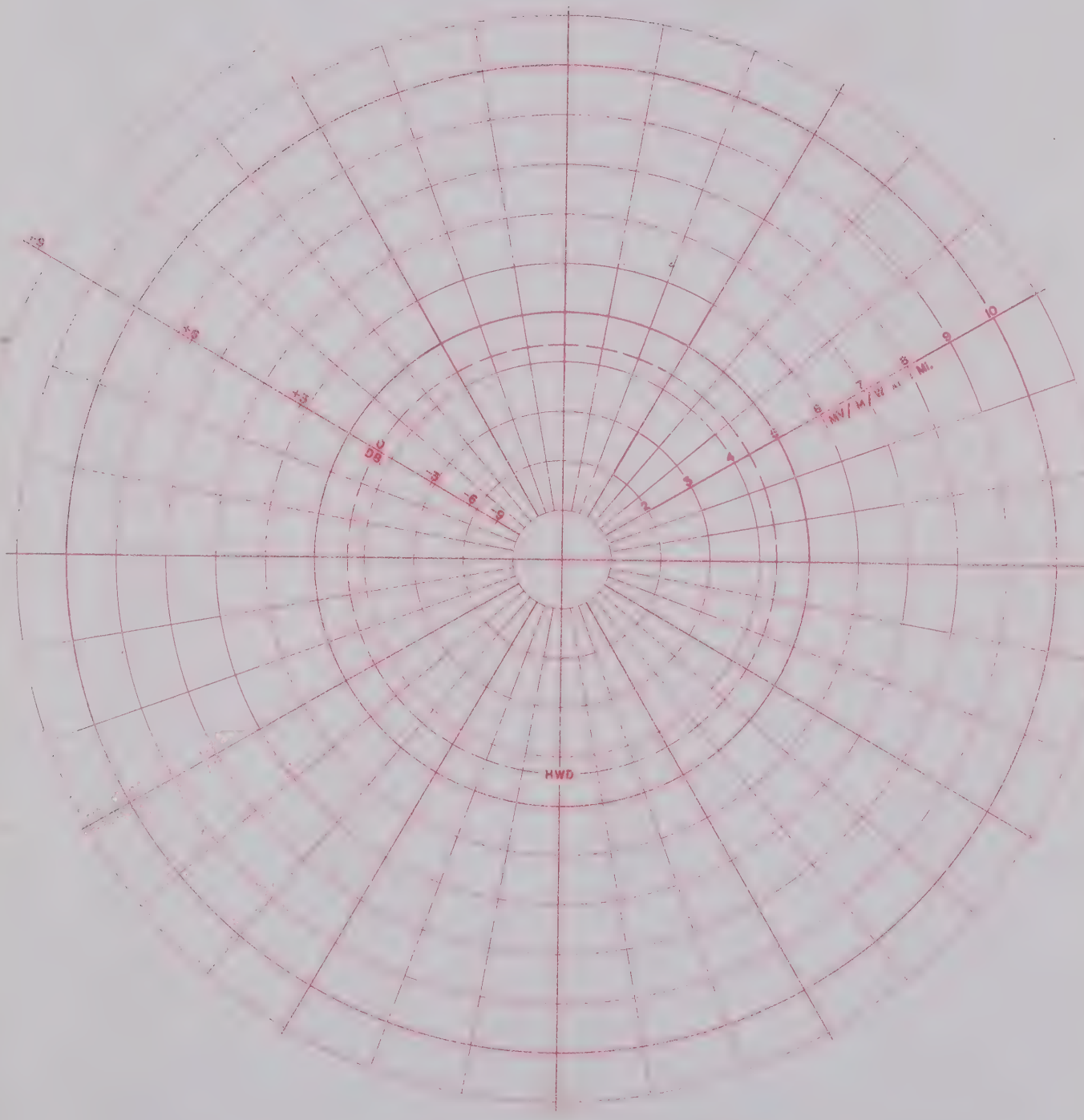

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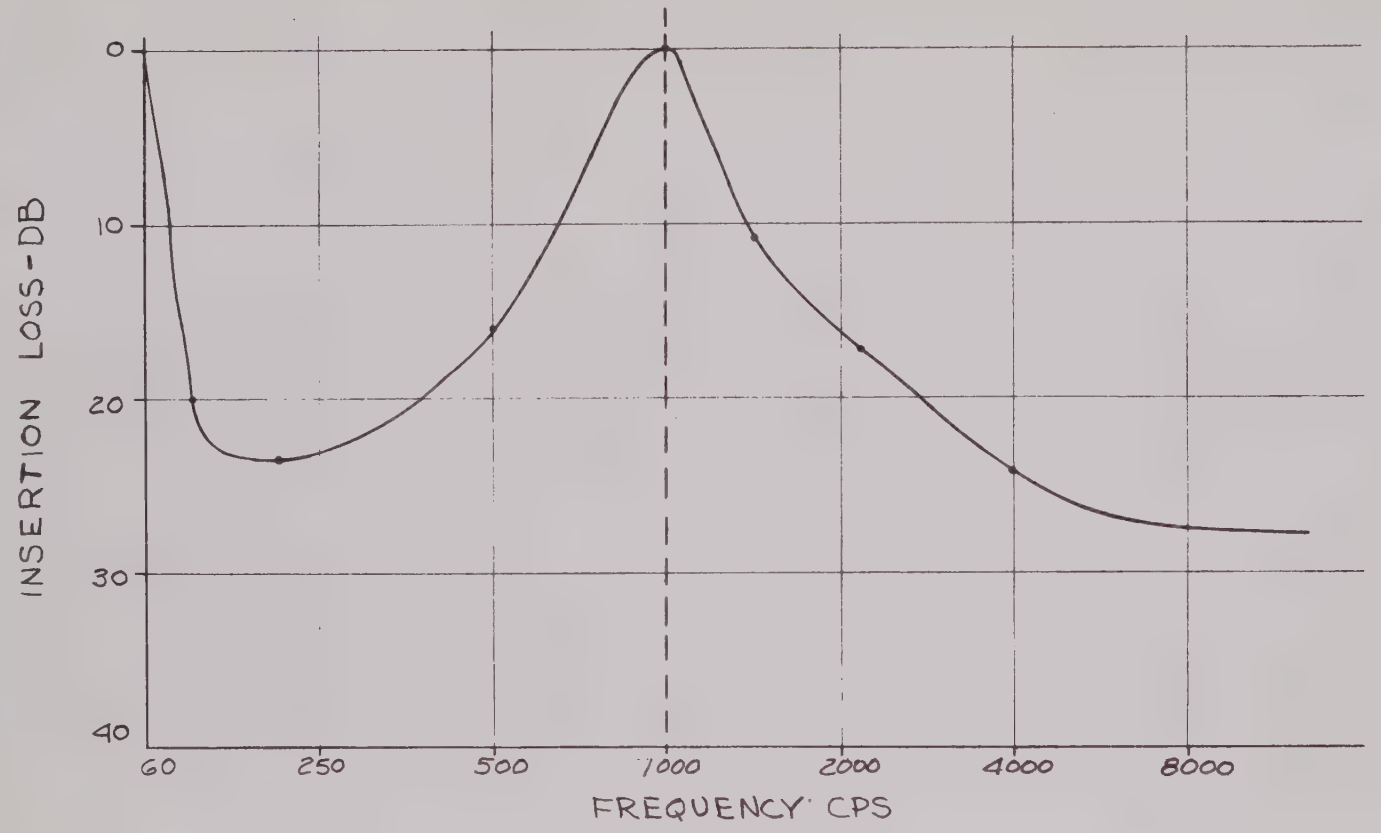
3.4 IF Amplifier and Power Supply

The if amplifier (Drawing No. 6) is a synchronous, single-tuned amplifier with a center frequency of 65 mc. The if amplifier input stage consisting of V1-3 (6BC4) and V2-2 (6CB6) is a grounded cathode triode, grounded grid triode input amplifier which provides a low if noise figure. V3-3 through V5-3 (6CB6's) are single-tuned stages with the manual gain control voltage applied to their grids. The normal range of this gain control voltage is from -1 v to -5.5 v. V6-5 (6CB6) is a single-tuned amplifier with the agc gain control voltage applied to its grid (Models 402A and 402C only). When the AGC ON-OFF switch (S2-2) is turned OFF, and in Models 402 and 402B, the grid of V6-5 is biased at -2.5 v dc by the voltage divider R56-3 and R57-3.

The if amplifier output stage V7-3 (6CB6) drives two detector circuits. CR1-3 (1N295) is a conventional crystal detector which provides a video output signal for the afc circuit and the monitor oscilloscope. F1-3 (0.01 amp fuse) is a bolometer detector, magnetically coupled to the plate coil of the final if stage. The bolometer provides a square-law output which is fed through a low impedance bolometer filter (FL1-3). This filter attenuates the harmonics of 1000 cps present in the bolometer output signal. See Figure 4. DC bolometer current is coupled through J2-3 from the bolometer amplifier associated with the antenna pattern recorder in use. A 40 db dynamic range is obtained from the bolometer with an output linearity to within 1 db over the entire 40 db signal range. See Figure 1.

The +150 v dc power supply for the if amplifier utilizes four parallel 5687 triodes as series regulator tubes and a 12AX7 voltage amplifier. The supply will furnish a dc current of 100 ma with negligible output ripple.

A vr tube regulated supply consisting of V13-3 (6X4) and V14-3 (OB2) provides a -105 v low current bias voltage which is used for the if amplifier manual gain control voltage as well as for bias for the agc amplifier and the sweep amplifier. This supply delivers a current of approximately 20 ma.



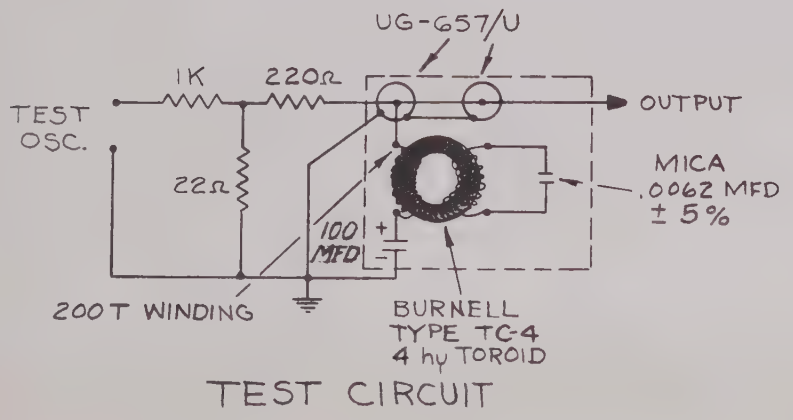


Figure No. 4

Bolometer Filter Test Circuit and Insertion Loss vs. Frequency Curve

3.5 RF Unit

The RF Unit furnished with Models 402 and 402A is internally connected to permit signal reception in the frequency range from 2 to 75 kmc. The RF Unit furnished with Models 402B and 402C can be connected as the Model 402 and the Model 402A or to permit signal reception in the frequency range from 30 to 2000 mc.

Drawing No. 7 shows the RF Unit furnished with Models 402 and 402A and Drawing No. 8 shows the RF Unit furnished with Models 402B and 402C. In all models to permit the reception of signals in the frequency range from 2 to 75 kmc, the RF Unit is connected to utilize the carcinotron (V1-4), the variable attenuator (AT1-4), and the frequency-selective tee. A 6 v dc filament voltage is supplied to the carcinotron by the rectifier and filter combination consisting of T1-4, CR1-4, R1-4, and C1-4. Since the filament currents of various carcinotrons are not the same, R1-4 is made adjustable to permit the filament voltage to be correctly set. The delay line voltage, the anode voltage and the grid voltage for the carcinotron are furnished by the Carcinotron Power Supply which is fed to the RF Unit through P22-4. The variable attenuator (AT1-4) located in series with the carcinotron output is a Tri-Plate, 50-ohm attenuator which provides an adjustable attenuation of at least 15 db. The carcinotron power level is operated at a maximum to provide the most uniform frequency modulation. The variable CARCINOTRON OUTPUT ATTENUATOR is normally adjusted to provide a maximum signal-to-noise ratio with a crystal current not exceeding 5 ma. The carcinotron output signal is coupled through the frequency-selective tee through J8-4 and the receiver input cable to the crystal holder. The 65 mc if signal, which is returned from the crystal holder through J8-4, is directed by the frequency-selective tee to the IF Amplifier. The frequency-selective tee employs a 15 uuf capacitor to block the 65 mc signal from the carcinotron and a low-pass transmission line filter to block the carcinotron 2 to 4 kmc signal from the IF Amplifier. The characteristics of the frequency-selective tee are shown by Figure 5.

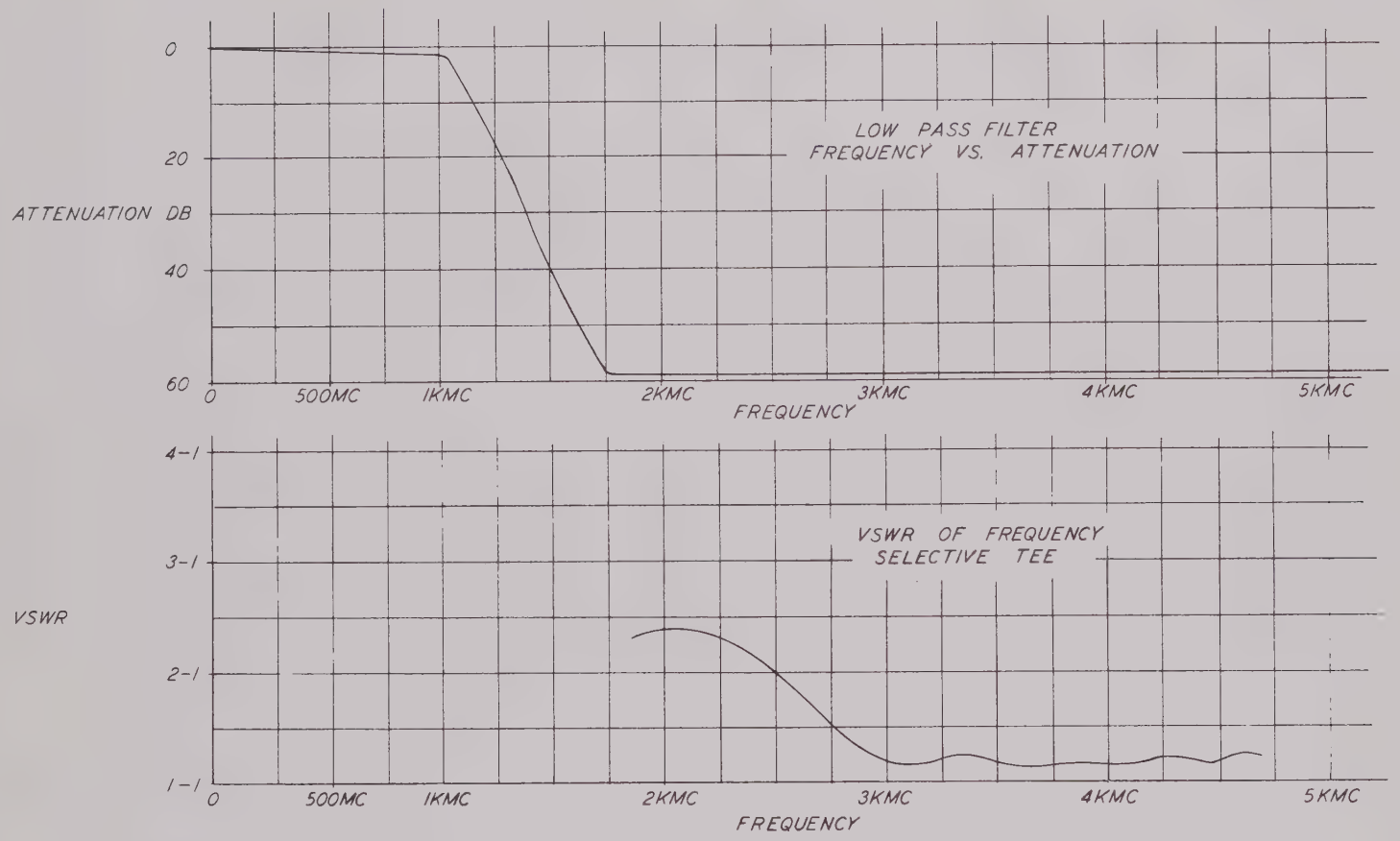


Figure No. 5

Low Pass Filter Attenuation and Frequency
Selective Tee VSWR Characteristics

When the RF Unit is connected for the reception of signals between 30 mc and 2 kmc (Models 402B and 402C only), the carcinotron output serves as a first local oscillator signal and is fed through the variable attenuator to the first mixer. The first mixer contains a 1N21D crystal which provides conversion of input signals to a 2100 mc first if signal. The first mixer output is coupled directly to a 2100 ± 10 mc narrow band cavity which serves as a selective isolator between the first and second mixer. The cavity output is coupled to the second mixer together with the 2035 mc output of the second local oscillator. The 2100 mc first if signal is converted into a 65 mc second if signal at the second mixer. The output of the second mixer is fed through a low-pass transmission line filter to the 65 mc if amplifier input. This low-pass transmission line filter has the same characteristics as the transmission line filter employed in the frequency-selective tee and isolates the second local oscillator signal from the if amplifier input.

The second local oscillator (V2-4) employs a 5675 pencil triode located in a coaxial cavity housing which provides a shorted 1/4 wavelength plate line and a shorted 3/4 wavelength cathode line at the frequency of oscillation. Plate voltage (+325 v dc) and filament voltage (6v dc) are supplied by the low voltage power supply through P24-4. The second local oscillator output is coupled from the plate line by a coupling loop. The loop position is adjustable and permits adjustment of the second-mixer crystal current to approximately 1 ma.

The plate current of the 5675 pencil triode may be monitored across R4-4 using test points TP1-4 and TP2-4. R4-4 is a 1000-ohm resistor and the plate current is indicated by a 1 ma-per-volt relationship. R2-4 is adjustable and permits fine adjustment of the plate current and the oscillator output level. S1-4, the SECOND LOCAL OSCILLATOR ON-OFF switch, permits removal of the second local oscillator filament and plate voltages when using the high frequency portion of the RF Unit.

3.6 Low Voltage and Comparator Amplifier Power Supplies

The Low Voltage and Comparator Amplifier Power Supplies (Drawing No. 9) furnish dc voltages to the Control Unit and the comparator amplifier of all models of the Series 402 Wide Range Receiving Systems. In models which include the AGC Amplifier and/or the low frequency rf system, dc voltages for the AGC Amplifier and the second local oscillator are supplied by this unit.

The low voltage regulated supply furnishes +325 v dc rated at 180 ma to the Control Unit, the AGC Amplifier, and the RF Unit second local oscillator. This supply employs a rectifier V1-5 (5U4GA), a series regulator V2-5 (6080), an amplifier V3-5 (5751), and a voltage reference tube V4-5 (5651). R19-5 permits adjustment of the output voltage, normally +325 v dc. Line voltage variations of ±10% and load variations of 100% produce changes in the output dc voltage of less than ±1%.

A 6 v dc filament voltage at 100 ma for the RF Unit second local oscillator tube is furnished by rectifier and filter consisting of T4-5, CR1-5, and C6-5. This supply is used only with Models 402B and 402C but is included in all models. The value of the resistor across this supply is determined by the filament current of the 5675 tube and is chosen to provide 6 v across the tube filament. Transformers T1-5 and T3-5 provide two 6.3 v ac at 6 amp filament supplies for the Control Unit and the AGC Amplifier.

The +300 v dc and the -300 v dc power supplies furnish balanced voltages for the comparator amplifier associated with the Carcinotron Power Supply. The +300 v dc at 90 ma supply is electronically regulated and consists of a rectifier V5-5 (5V4GA), a series regulator V6-5 (6BX7) and two amplifiers V7-5 and V8-5 (12AX7's). The reference voltage for the +300 v dc supply is derived from the -300 v dc at 15 ma, vr tube regulated supply. The negative supply has an internal impedance of essentially 1000 ohms, the value of R30-5. Consequently, its output voltage deviates from -300 v by an amount equal to the voltage drop produced by the load

current through R30-5. Since the reference voltage for the positive supply is obtained from the load side of R30-5, the output voltages of the two supplies are always equal in magnitude, normally + 285 v dc and - 285 v dc.

3.7 Carcinotron Power Supply

A. General: Figure 6 shows a block diagram of the Carcinotron Power Supply and associated circuits. The Raytheon QK518 carcinotron tunes electronically from 2 to 4 kmc as the voltage between its delay line and its cathode is varied from approximately 150 volts to 1500 volts. The delay line (connected internally to the metal shell of the tube) is grounded and the cathode operates at a variable negative potential. The anode is maintained at a fixed positive potential with respect to the cathode, approximately 150 volts. An adjustable bias of zero to -50 volts applied to the control grid varies the beam current between zero and 40 milliamperes.

Because tuning sensitivities in excess of 15 megacycles-per-volt may be encountered in harmonic operation of the receiver, the delay line voltage must be highly stabilized to avoid hum modulation and drift. The carcinotron frequency is also sensitive to changes in anode voltage and, to a much lesser extent, to the grid voltage. A dc filament supply is required to prevent hum modulation.

The delay line supply consists essentially of a rectifier, a reference voltage source, and a differential comparator amplifier controlling a series regulator tube. The positive or "common" terminal of the supply is returned to ground through the delay line current meter and through the secondary of a transformer to which the sweep voltage is applied. The sweep sawtooth is thus impressed upon the power supply as a whole. To insure freedom from drift and transient bounce a full-voltage reference potential is used, derived from a string of eighteen OG3/85A2 reference tubes operated from a current regulator. By means of the CARCINOTRON TUNING helipot and the CARCINOTRON TUNING RANGE SWITCH, the potential difference between the negative terminal of the supply and the first input to

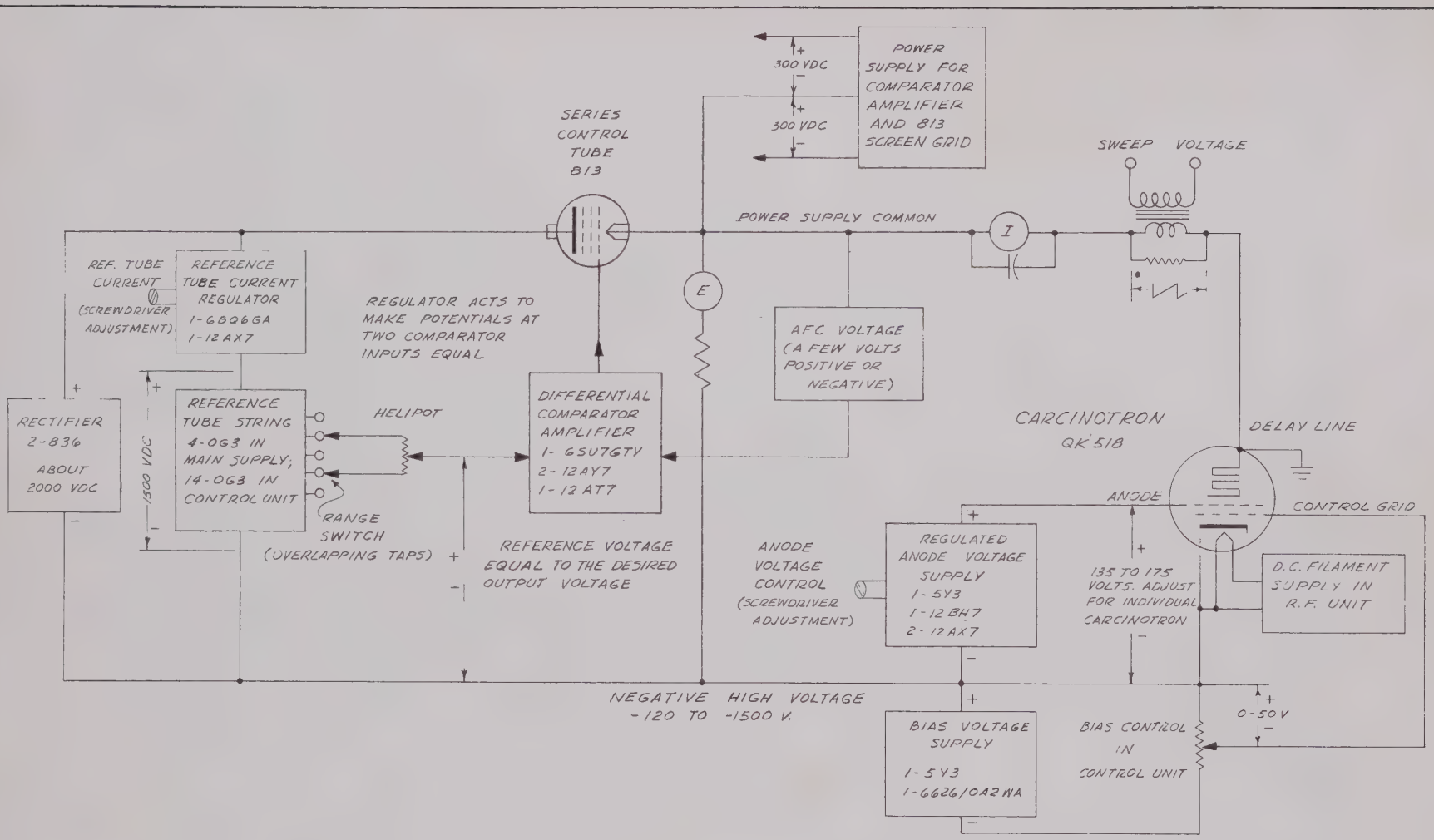

300 VDC
300 VDC
POWER SUPPLY FOR COMPARATOR AMPLIFIER AND 813 SCREEN GRID
SERIES CONTROL TUBE 813
SWEEP VOLTAGE
POWER SUPPLY COMMON
I
E
REF. TUBE CURRENT (SCREWDRIVER ADJUSTMENT)
REFERENCE TUBE CURRENT REGULATOR 1-6BQ6GA 1-12AX7
REGULATOR ACTS TO MAKE POTENTIALS AT TWO COMPARATOR INPUTS EQUAL
AFC VOLTAGE (A FEW VOLTS POSITIVE OR NEGATIVE)
RECTIFIER 2-836 ABOUT 2000 VDC
REFERENCE TUBE STRING 4-0G3 IN MAIN SUPPLY; 14-0G3 IN CONTROL UNIT
1500 VDC
HELIPOT
DIFFERENTIAL COMPARATOR AMPLIFIER 1-6SU7GTV 2-12AY7 1-12AT7
CARCINOTRON QK 518
DELAY LINE
ANODE
CONTROL GRID
RANGE SWITCH (OVERLAPPING TAPS)
REFERENCE VOLTAGE EQUAL TO THE DESIRED OUTPUT VOLTAGE
ANODE VOLTAGE CONTROL (SCREWDRIVER ADJUSTMENT)
REGULATED ANODE VOLTAGE SUPPLY 1-5Y3 1-12BH7 2-12AX7
135 TO 175 VOLTS. ADJUST FOR INDIVIDUAL CARCINOTRON
D.C. FILAMENT SUPPLY IN R.F. UNIT
NEGATIVE HIGH VOLTAGE -120 TO -1500 V.
BIAS VOLTAGE SUPPLY 1-5Y3 1-6626/0A2WA
BIAS CONTROL IN CONTROL UNIT
0-50 V

Figure No. 6

Block Diagram of the Carcinotron Power Supply and Associated Circuits

the comparator amplifier may be set equal to the desired output voltage. Through degenerative feedback, the regulator acts to make the potential of the first comparator input equal to that of the second, which in the absence of an afc correction signal is at "common" potential. It will be seen that any departure of the output voltage from the selected reference voltage will appear as a difference in potential between comparator inputs; this error signal, highly amplified and applied to the series tube control grid, causes the voltage drop across this tube to change in such direction as to oppose the departure. An afc correction signal, applied between the second comparator amplifier input and common, causes the output voltage to change by an amount equal to the correction signal.

A separate regulated power supply for the comparator amplifier and for the series regulator tube screen grid, returned to common rather than to ground, is located on the Low Voltage and Comparator Amplifier Power Supply chassis. The regulated supplies for the carcinotron anode and control grid are conventional. The details of these and other individual circuits are discussed in the following sections.

B. High Voltage Rectifier: The high voltage rectifier (Drawing No. 10) is a conventional full-wave circuit using type 836 high-vacuum rectifiers V1-6 and V2-6, followed by a condenser-input filter consisting of C7-6, L1-6, and C8-6. An output voltage of approximately 2000 volts is developed across the bleeder (R21-6 and R22-6).

C. Reference Voltage Source: The reference tube string includes fourteen OG3/85A2's located on the Control Unit, V13-1 through V26-1 (Drawing No. 2) with four additional regulator tubes located on the Carcinotron Power Supply chassis, V12-6 through V15-6 (Drawing No. 10). The cathode of V13-1 is the negative terminal of the reference source and is connected to the negative terminal of the power supply. The anode of V12-6 is the positive terminal of the reference supply, at a potential of 1530 volts with respect to the negative terminal.

The current through the reference tube string is held constant by a regulator consisting of the series tube V10-6 (6BQ6GA) and the differential comparator V11-6 (12AX7). Any change in the voltage drop across R26-6 results in a change in potential between the two grids of V11-6, causing an amplified change in the voltage at the grid of V10-6. Through the usual degenerative feedback action, the voltage drop across V10-6 changes to oppose the disturbance. The silicon diode CR1-6 rectifies the heater voltage to provide a screen-grid potential of about eight volts for V10-6. The screwdriver-adjust REFERENCE TUBE CURRENT control, R28-6, is normally set for a drop of 100 volts across R26-6, corresponding to a current of about 3.7 milliamperes.

The CARCINOTRON TUNING RANGE switch S3-1 connects the CARCINOTRON TUNING potentiometer R98-1 across selected banks of five reference tubes; successive banks overlap by one tube or 85 volts. Resistors R97-1 and R99-1 reduce the tuning overlap between ranges to about 30 volts.

D. Comparator Amplifier: The Comparator Amplifier consists of direct-coupled differential amplifier stages, V16-6 (6SU7GTY), V17-6 and V18-6 (12AY7's) followed by an output cathode follower V19-6 (12AT7). A control voltage from the reference-source CARCINOTRON TUNING potentiometer is applied to one grid of the low grid-current input tube (V16-6). The afc correction signal is applied between the other grid and the power supply common, which is at ground potential. The neon bulb NB1-6 ignites momentarily when the RANGE switch setting is changed, to protect the amplifier from overloads.

The plates of V16-6, at a potential of about 100 volts, are connected directly to the grids of V17-6. The plates of V17-6, operating at a potential of about 200 volts, are coupled to the grids of V18-6 through a voltage-divider network to provide a dc level shift of about -80 volts. The output plate of V18-6 is in turn coupled through a voltage divider to the grid of the cathode-follower section of V19-6. The second section of V19-6 is arranged to provide a constant-current cathode load for the first section. The control

voltage applied to the series tube V3-6 (813) grid ranges from approximately -10 to -100 volts depending on the operating conditions.

E. Series Regulator Tube: The series regulator tube V3-6 (813) is operated as a pentode with the screen voltage provided by the positive 300 volt supply. The center-tap of the 813 filament winding of T2-6 is the positive or "common" terminal of the delay line supply. This point is returned through the DELAY LINE CURRENT meter M3-1 and through the secondary of the sweep coupling transformer T5-1 to the grounded delay line of the carcinotron.

F. Bias and Anode Voltage Supplies: V5-6 (5Y3) is connected as a half-wave rectifier for the carcinotron bias supply. Operating from a 400 v tap on the secondary of T1-6, it develops, across C15-6, a potential of about -500 volts with respect to the (carcinotron cathode) terminal of the delay line supply. The regulator tube V7-6 (6626) maintains a constant voltage of -150 volts at the output of the filter network. R47-6 and the CARCINOTRON GRID BIAS control R101-1 form a voltage divider from which an adjustable bias of zero to -50 volts is derived.

V4-6 (5Y3) is a full-wave rectifier for the anode supply, operated from the 400-0-400 v taps of T1-6. It develops about 340 volts across C12-6. The series tube V6-6 (12BH7A) and the comparator amplifiers V9-6 and V8-6 (12AX7's) are arranged in a conventional degenerative-feedback regulator circuit, which acts to keep the two grids of V9-6 at the same potential. The -150 volt output of the bias supply serves as a reference potential to which a sampling divider (R38-6, R39-6, R46-6) is returned; the output anode voltage assumes a value which places the tap of R39-6 at the carcinotron cathode potential. Normal anode voltages for various carcinotrons range between 135 and 175 volts.

G. Line Voltage Circuits: Closure of the LOW VOLTAGE switch (S1-3) applies power through fuse (F2-6) to all filament transformers and to

the heater element of the thermostatic-delay relay (K2-6) through a set of the normally closed contacts of relay K3-6. After a time delay of approximately one minute following the closure of the LOW VOLTAGE switch, the thermostatic-time delay relay closes applying power to K3-6. Closure of K3-6 connects power through fuse F1-6 to the READY light and to K1-6 and removes power from the heater element of K2-6. K3-6 will remain energized until line voltage is removed from its holding circuit. If the HIGH VOLTAGE switch is OFF when K3-6 closes, the READY light will come on; if the HIGH VOLTAGE switch is ON, K1-6 will close applying line voltage to the high-voltage transformer, T1-6, and the high-voltage pilot lamp, DS2-3. Closure of K1-6 also applies dc voltage to the screen grid of V3-6 .

IV. SYSTEM ADJUSTMENTS

Before any adjustments to the receiver are made, the LOW VOLTAGE switch on the IF Amplifier and Power Supply chassis should be turned ON and the receiver operated for a ten-minute warm-up period (exceptions are noted). An rf signal source will be required for some adjustments.

4.1 Control Unit

A. Internal Sync Oscillator and Phase Shift Circuit: Following the warm-up period, observe the output of the internal oscillator (pin 3 of V1-1) on an oscilloscope calibrated both in sweep time and vertical deflection. Adjust the CARCINOTRON SWEEP FREQUENCY control, R1-1, on the front panel for an output frequency of 1000 cps. (The normal adjustable frequency is from 950 to 1050 cps.) Adjust the OSCILLATOR FEEDBACK control R4-1 on the top of the chassis for a 90-volt peak-to-peak sine wave. Next, observe the waveform at the cathode (pin 3) of V4B-1 and adjust the CLIPPER SYMMETRY control, R25-1, on the top of the chassis for a symmetrical 60-volt peak-to-peak square wave.

B. AFC Circuit: Apply a cw signal source (either high or low frequency) to the appropriate receiver input connector, turn the AFC ON-OFF switch OFF, turn the HIGH VOLTAGE ON-OFF switch ON and tune the receiver to obtain a signal-to-noise ratio of better than 2 to 1 as indicated on the monitor oscilloscope. (The internal oscillator frequency and the clipper circuit should have been adjusted as described in Section A above.) Observe the output waveform of the narrow band amplifier V9-1 (pin 2) on a test oscilloscope using a high impedance probe (1 megohm or more) and adjust the core of the toroid L2-1 on the top of the afc chassis for maximum response.

The proper method of adjusting each of the afc cathode-coupled clippers is to reduce the receiver gain until the signal at the output of the stage being adjusted just begins to saturate. The appropriate symmetry

control can then be adjusted for equal limiting of the signal on the positive and negative peaks. Using this method, observe the waveform with a test oscilloscope at pin 6 of V9-1 and adjust R61-1. Then observe the waveform at pin 6 of V10-1 and adjust R71-1. To properly adjust the third cathode-coupled clipper, observe the waveform at pin 6 of V11-1 and adjust R80-1 and the core of the toroid L3-1, located on top of the chassis, for a maximum sine wave amplitude.

The AFC METER BALANCE control, R92-1, should be adjusted for a null or zero meter indication with the AFC ON-OFF switch in the OFF position.

4.2 IF Amplifier and Power Supply

A. Power Supply: With a dc voltmeter connected between the red (positive) and black (negative) wired terminals on the terminal strip at the end of the large terminal board, set the +150 V ADJ control on top of the chassis for a meter reading of 150 v dc.

B. IF Amplifier: The IF Amplifier should be aligned using a 65 mc signal generator capable of 1000 cps amplitude modulation with an output impedance of 50 ohms. Connect the signal generator output to the if amplifier input jack on the RF Unit and set the signal generator level and the RECEIVER GAIN control for an unsaturated if amplifier output signal indication on the monitor oscilloscope. Tune each of the if amplifier peaking adjustments for a maximum if amplifier output.

4.3 RF Unit

A. First IF Cavity: (Models 402B and 402C only) With the Wide Range Receiving System LOW VOLTAGE switch turned OFF, apply a 2100 mc, 1000 cps amplitude modulated signal to the LOW FREQUENCY RECEIVER INPUT connector. Connect the LOW FREQUENCY MIXER IF OUTPUT connector to a 1000 cps narrow band standing wave indicator. Tune

the first if cavity for a maximum signal level on the indicator. In the event a 2100 mc signal source is not available, a 1050 mc signal source may be used. The second harmonic of 1050 mc will be generated in the first mixer crystal and then coupled into the first if cavity; the cavity will not tune to 1050 mc.

B. Second Local Oscillator: (Models 402B and 402C Only) Tuning of the local oscillator to 2035 mc requires connection of the Wide Range Receiving System for low frequency operation. Replace the second local oscillator input to the second mixer with a 2035 mc cw signal from an external signal generator and adjust its power level for 1 ma of crystal current. Apply a cw signal (30 to 2000 mc) to the LOW FREQUENCY RECEIVER INPUT connector. The LOW VOLTAGE and the HIGH VOLTAGE switches should be ON. Tune the receiver for an unsaturated signal on the monitor oscilloscope. Remove the 2035 mc input to the second mixer and connect the second local oscillator. Tuning of the second local oscillator is accomplished by adjustment of the two knurled knobs, one located at each end of the oscillator cavity. To initially obtain oscillation, set one of the tuning knobs to the center of its adjustable range and adjust the second knob for oscillation. Adjustment of the two knobs together to maintain oscillation is necessary when tuning the oscillator.

Oscillation is indicated by a rise in crystal current and correct frequency is indicated by a maximum signal on the monitor oscilloscope. The oscillator plate current can be monitored by measuring the voltage between TP1-4 and TP2-4 with a 20,000 ohm-per-volt dc meter set to a scale of at least 30 v. The voltage measured should not exceed 30 volts indicating 30 ma of plate current. The second local oscillator output power should be sufficient to provide 1 ma of crystal current. The oscillator power output can be adjusted by positioning the output coupling loop and by adjusting the second local oscillator plate voltage potentiometer, R2-4.

4.4 Low Voltage and Comparator Amplifier Power Supply

The Low Voltage Power Supply (+325 v at 200 ma) should be adjusted to +325 ±5% v dc using the +325 V ADJ potentiometer, R39-6. This voltage may be measured between the red test jack (positive) and ground. The +325 volt supply normally furnishes the following currents to the various receiving system units:

a.	+325 volt regulator	20 ma (All Models)
b.	Control Unit	100 ma (All Models)
c.	Monitor Oscilloscope	10 ma (All Models)
d.	Second Local Oscillator	20 ma (Models 402B and 402C Only)
e.	AGC Amplifier	40 ma (Models 402A and 402C Only)

The Comparator Amplifier Power Supplies are self-regulating and require no adjustments. These voltages are normally +285 v dc and -285 v dc.

4.5 Carcinotron Power Supply

Essentially all voltages associated with the Carcinotron Power Supply are variable. The carcinotron grid bias voltage and delay line voltage controls are located on the Control Unit front panel. (Operation of these controls is described in Section II, OPERATING INSTRUCTIONS.) The carcinotron anode voltage is set by the ANODE VOLTAGE control, R39-6, and measured between TP1-6 (positive) and TP2-6. This voltage should be set and maintained at the potential recommended by the carcinotron manufacturer. This data is in an envelope attached to the carcinotron aluminum shield.

The current through the reference tube string of OG3/85A2's should be maintained at 3.7 ma. This current is set by measuring the voltage drop across R26-6 (27 k ohms) available between TP3-6 (positive) and TP4-6. A 20,000 ohms-per-volt meter set to a scale of 150 v or greater should be used. The REFERENCE TUBE CURRENT control, R28-6, should be adjusted for a meter reading of 100 v indicating 3.7 ma.

V. SERVICE AND MAINTENANCE INSTRUCTIONS

In the event of faulty operation of any part of the receiving system, a visual inspection of fuses, tubes, cable connectors and other components should be completed first. Afterwards, standard repair procedures should be followed to isolate the trouble to a particular unit, then to a single stage and finally to the defective item. To aid in the maintenance procedure, the schematic diagrams provide the values of many dc supply voltage and waveform amplitudes. To permit rapid location of the individual stages, the tube numbers and types are labeled on the chassis.

5.1 Replacement of the Carcinotron (QK518)

With the receiving system turned OFF, remove the aluminum cover which shields the carcinotron. This cover is loosened by the removal of the mounting screws located beneath the RF Unit chassis which secure this cover to the chassis. The slotted end of the cover permits the shield to be lifted from the carcinotron after removal of the octal socket. The carcinotron may be taken out following the removal of the four base mounting screws. The new tube may now be mounted in position and secured by the four base mounting screws. Since the carcinotrons require large mounting tolerances, the mounting holes are slotted both on the chassis and on the tube base to permit proper alignment with the cover.

Before a newly installed tube is placed in operation, both the filament and the anode voltages must be properly adjusted. Locate the variable 2-ohm resistor R1-4 mounted below the RF Unit chassis and adjust its sliding contact for maximum resistance between the two terminals employed. Connect the octal tube socket to the carcinotron plug. Turn the receiving system LOW VOLTAGE switch ON, measure the voltage between pins 7 and 8 of the tube socket and adjust R1-4 for 6 v dc. This voltage may be measured directly from the tube pins or across the 4000 uf electrolytic capacitor

located beneath the RF Unit chassis. Tighten the slider of R1-4 and remove the meter. Connect the meter, set to a scale to read 300 v dc, between test points TP1-6 (positive) and TP2-6 (negative) located on the Carcinotron Power Supply chassis. This voltage should be set to the anode voltage recommended on the specification sheet for the new carcinotron. The ANODE VOLTAGE adjustment (R39-6) is located next to the anode voltage test jacks. Upon completion of these voltage adjustments, the carcinotron is ready for operation with the receiving system.

5.2 Replacement of the Second Local Oscillator (RCA5675)(Models 402B and 402C Only)

In the event of failure of the second local oscillator tube, the second local oscillator cavity should be removed from the RF Unit to facilitate tube replacement. Figure 7 shows the internal assembly of this cavity. The plate end of the cavity is removed from the tube by disconnecting the plate line plug and removing the four screws which lock the circular flanges together. After removal of the plate end of the cavity, the tube may be removed from the cathode end of the cavity and the filament leads unsoldered. Carefully solder the filament leads to the replacement tube and reassemble the cavity. The second local oscillator may now be retuned as described in Section 4.3.

5.3 Replacement of Mixer Crystals (1N21D)(Models 402B and 402C Only)

Each of the first-mixer and the second-mixer portions of the 30 to 2000 mc, low frequency rf system contains a 1N21D crystal which serves as the detecting diode. To replace either of these diodes, the mixer in question must be removed from the RF Unit. The crystal is located inside the male connector end of the mixer labeled CRYSTAL. To obtain access to the crystal, remove the four screws which secure this connector to the mixer.

5.4 Carcinotron Power Supply Repair

Although standard trouble-shooting techniques are applicable in servicing the Carcinotron Power Supply, interaction among circuits connected in

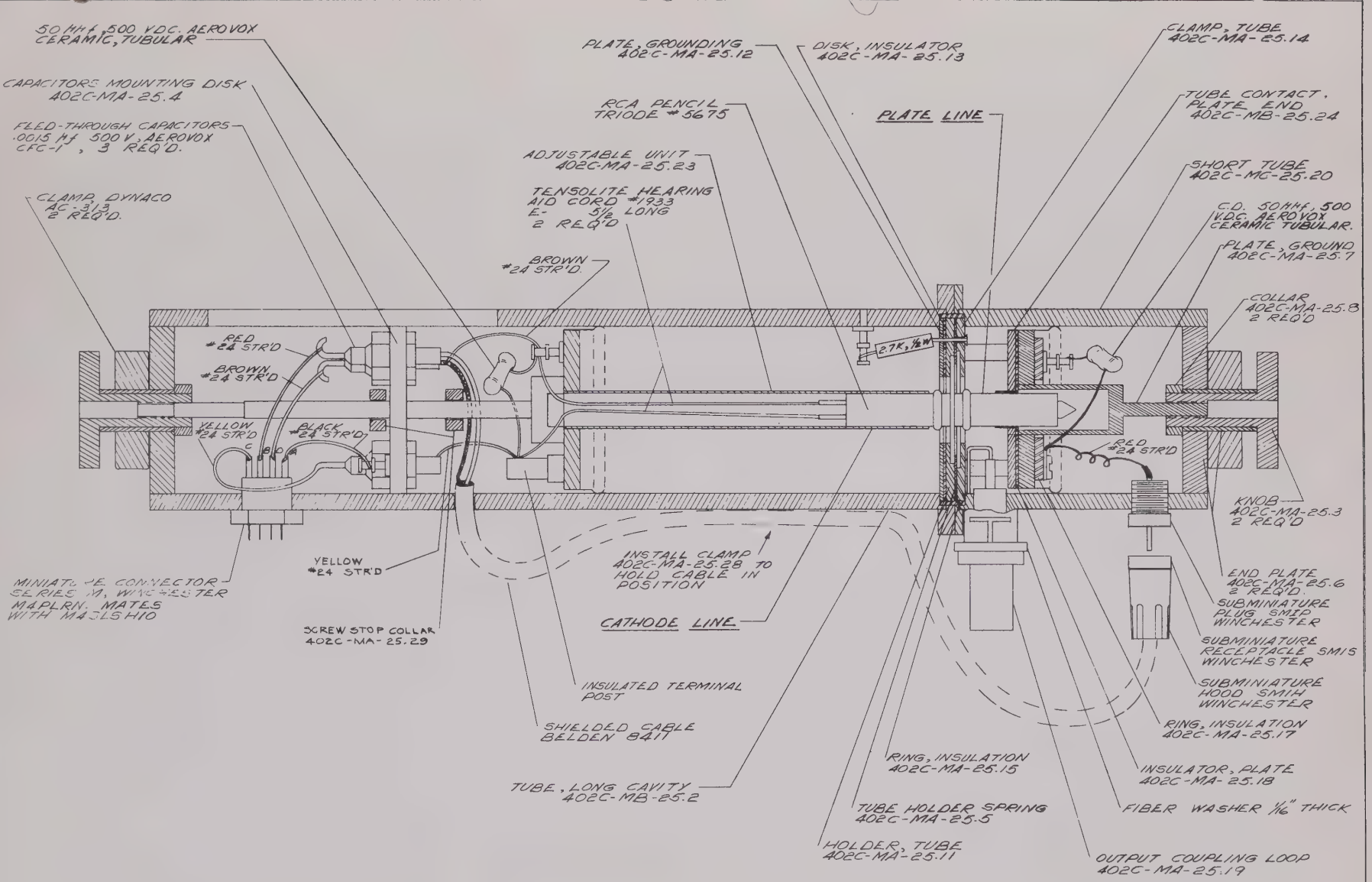

50 MMf, 500 VDC, AEROVOX CERAMIC, TUBULAR
CAPACITORS MOUNTING DISK 402C-MA-25.4
FEED-THROUGH CAPACITORS .0015 Mf, 500 V, AEROVOX CFC-1, 3 REQ'D.
CLAMP, DYNACO AC-313 2 REQ'D.
PLATE, GROUNDING 402C-MA-25.12
DISK, INSULATOR 402C-MA-25.13
RCA PENCIL TRIODE #5675
ADJUSTABLE UNIT 402C-MA-25.23
TENSOLITE HEARING AID CORD #1933 E- 5½ LONG 2 REQ'D
BROWN #24 STR'D.
PLATE LINE
CLAMP, TUBE 402C-MA-25.14
TUBE CONTACT, PLATE END 402C-MB-25.24
SHORT TUBE 402C-MC-25.20
C.D. 50 MMf, 500 V.D.C. AEROVOX CERAMIC TUBULAR.
PLATE, GROUND 402C-MA-25.7
COLLAR 402C-MA-25.8 2 REQ'D
RED #24 STR'D
BROWN #24 STR'D
YELLOW #24 STR'D
BLACK #24 STR'D
2.7K, ½W
RED #24 STR'D
KNOB 402C-MA-25.3 2 REQ'D
MINIATURE RECEPTACLE SERIES M, WINCHESTER MAPLRN; MATES WITH MAPLSHIO
YELLOW #24 STR'D
INSTALL CLAMP 402C-MA-25.28 TO HOLD CABLE IN POSITION
END PLATE 402C-MA-25.6 2 REQ'D.
SUBMINIATURE PLUG SMIP WINCHESTER
SUBMINIATURE RECEPTACLE SMIS WINCHESTER
SUBMINIATURE HOOD SMIH WINCHESTER
CATHODE LINE
SCREW STOP COLLAR 402C-MA-25.29
INSULATED TERMINAL POST
SHIELDED CABLE BELDEN 8411
RING, INSULATION 402C-MA-25.17
RING, INSULATION 402C-MA-25.15
INSULATOR, PLATE 402C-MA-25.18
TUBE, LONG CAVITY 402C-MB-25.2
TUBE HOLDER SPRING 402C-MA-25.5
FIBER WASHER 1/16" THICK
HOLDER, TUBE 402C-MA-25.11
OUTPUT COUPLING LOOP 402C-MA-25.19

Figure No. 7

Local Oscillator Cavity Wiring Diagram

a degenerative feedback loop may complicate isolation of the trouble. The steps listed below are suggested as a means of narrowing the field of search. In all servicing, observe the following precautions: (1) Be careful in dealing with the LETHAL VOLTAGES PRESENT IN MOST CIRCUITS. (2) Be sure that both the cabinet of the receiver and one side of the power line are grounded. Otherwise, a primary-to-secondary short in one of the transformers may place high voltage on the cabinet or on the power line. (3) Do not operate the carcinotron at delay-line voltages less than 100 volts or greater than 1500 volts, or at delay-line currents exceeding 40 milliamperes.

Procedure for isolation of trouble:

1. Turn both power switches OFF.
2. To protect the carcinotron, disconnect the cable from J6-6. Provide a temporary ground return: run a clip lead from "common" to the chassis. A point of convenient access to common is the terminal of C1-6 (the bathtub capacitor in the comparator subchassis) to which a black-white wire is connected.
3. Remove V1-6, V2-6 (836's) and V3-6 (813). (Caution: A defective bleeder resistor may leave charge on filter condensers and voltage on the plate caps.) Insulate the plate-cap leads from the chassis and from each other.
4. Turn the CARCINOTRON FREQUENCY MODULATION control fully counterclockwise.
5. Check operation of the Comparator Amplifier: Short the control-voltage input by placing a clip lead across the terminals of NB1-6. Turn the LOW VOLTAGE power switch ON. With the AFC switch OFF, turn the AFC GAIN control fully clockwise. A small variable dc test voltage can now be applied to the AFC input grid by variation of the AFC METER BALANCE control. Measure the amplifier output voltage with a 20,000 ohm-per-volt meter connected between ground and pin 4 of the V3-6 tube socket. Rocking the AFC METER BALANCE control should cause the output voltage to vary between saturation limits of about -120 and +50 volts, changing rapidly as the afc meter reading passes through zero. If satisfactory, remove the input short and proceed.

6. Check operation of the anode power supply: Connect a meter between TP1-6 (+) and TP2-6 and turn the HIGH VOLTAGE switch ON. The meter should read the anode voltage specified for the individual carcinotron in service. The range of adjustment provided by the ANODE VOLTAGE control should be from about 120 to 175 volts. Satisfactory operation of the anode supply indicates that the negative regulator V7-6 is also regulating properly. If trouble-shooting within the anode supply is required, remember that while removing V1-6 and V2-6 disables the 2000-volt rectifier, there is still 1500 v ac on the plate-cap leads.
7. Check operation of the reference voltage source: With the HIGH VOLTAGE switch OFF, insert V1-6 and V2-6 (836's) only; V3-6 still removed. Set the CARCINOTRON TUNING RANGE switch to the 120-480 volt position and turn the CARCINOTRON TUNING control fully counterclockwise. Connect a 20,000 ohm-per-volt meter between TP3-6 and TP4-6, and turn the HIGH VOLTAGE switch ON. Normal reference tube current is indicated by a meter reading of 100 volts; the REFERENCE TUBE CURRENT control should provide a range of adjustment from about 75 to 125 volts. If abnormal, the following points may be checked also: (1) The voltage between TP2-6 (negative) and TP3-6 should be 1630 volts; from TP2-6 to TP4-6, 1530 volts. Excessive voltage together with no reference tube current may indicate a defective OG3 in the string. (2) The output of the high voltage rectifier, normally around 2000 volts, may be measured between TP2-6 (negative) and the plate cap lead to V3-6.
8. Check operation of the delay-line voltage regulator: With the HIGH VOLTAGE switch OFF, momentarily ground the plate cap lead of V3-6 and then insert V3-6. Turn the HIGH VOLTAGE switch ON and check for normal control of indicated delay-line voltage. Trouble at this point, with all other circuits normal, may be due to (1) a defective 813, (2) a defect in the range switch and tuning Helipot circuits, or (3) an open or short in the control-voltage circuit to the comparator amplifier. The indication of the delay-line voltage meter may be checked against that of a meter connected between TP2-6 (-HV) and ground.

PARTS LIST (MODELS 402, 402A, 402B, 402C)

MANUFACTURERS' CODE LETTERS

CODE	MANUFACTURER
A	Aerovox Corporation
AB	Allen Bradley
AM	Amperite Company, Incorporated
AP	American Phenolic Corporation
AX	Amperex Electronic Corporation
B	Bussman Manufacturing Company
BC	The Bristol Company
BUR	Burnell and Company
CBS	CBS - Hytron
CC	Continental Carbon, Incorporated
CD	Cornell Dublier
C-H	Cutler Hammer, Incorporated
CRL	Centralab Division of Globe-Union, Incorporated
DA	Dale Products Company
F	Federal Telephone and Radio Company
GE	General Electric Company
HAM	Hammurland Manufacturing Company, Incorporated
HE	Heliopot Corporation
IRC	International Resistance Company
JFD	JFD Manufacturing Company
JN	E. F. Johnson Company
LF	Littelfuse, Incorporated
L-R	L-R Manufacturing Company
NC	National Electronics, Incorporated
O	Ohmite Manufacturing Company
PB	Potter and Brumfield

MANUFACTURERS' CODE LETTERS

CONTINUED

CODE	MANUFACTURER
R	Raytheon Manufacturing Company
RCA	Radio Corporation of America
RPC	Resistance Products Company
SA	Scientific-Atlanta, Incorporated
SAN	Saunders Associates, Incorporated
SN	Simpson Electric Company
SP	Sprague Products Company
ST	Sarkes Tarzian, Incorporated
SY	Sylvania Electric Products, Incorporated
T	Triad Transformer Corporation
TE	Tung-Sol Electric, Incorporated
TR	Transitron Electronic Corporation
UTC	United Transformer Corporation
W	Waterman Products Company
WA	Winchester Electronics, Incorporated
WE	Westinghouse Electric Corporation

TABLE OF PARTS

MODELS 402, 402A, 402B, 402C

SUBUNIT: CONTROL UNIT

Component Designation	Description	Mfr*	Mfr. Part No.
C1-1 C2-1 C16-1	Capacitor: fixed, mica 500 uuf, 2%, 500 V DCW	A	1464LS
C3-1 C5-1 C14-1 C18-1 C22-1 C25-1 C28-1 C29-1 C31-1 C39-1	Capacitor: fixed, paper 0.01 uf, 400 V DCW	A	P88N
C4-1 C26-1	Capacitor: fixed, paper 0.1 uf, 400 V DCW	A	P88N
C7-1 C20-1	Capacitor: fixed, paper 0.05 uf, 400 V DCW	A	P88N
C6A/B/C-1 C15A/B/C-1	Capacitor: electrolytic 10-10-10 uf, 400 V DCW	A	AFH3-30
C8A/B/C-1	Capacitor: electrolytic 40-40-40 uf, 150 V DCW	A	AFH3-10
C11-1 C13-1	Capacitor: fixed, mica 0.002 uf, 5%, 500 V DCW	A	1464
C17-1	Capacitor: fixed, metalized paper 0.25 uf, 400 V DCW	A	P92ZN
C24-1 C30-1	Capacitor: fixed, mica 0.0062 uf, 500 V DCW	A	1464
C27A/B-1 C32A/B-1 C35A/B-1	Capacitor: electrolytic 10-10 uf, 450 V DCW	A	AFH2-47

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
C33-1 C34-1	Capacitor: electrolytic 8 uf, 250 V DCW	SP	TVA1503
C36-1	Capacitor: fixed, paper 0.05 uf, 400 V DCW	A	P88N
C37-1	Capacitor: fixed, paper 0.05 uf, 1600 V DCW	A	P84CM
C38-1	Capacitor: electrolytic 25 uf, 150 V DCW	A	SRE
C40-1	Capacitor: fixed, paper .002 uf, 600 V DCW	A	P88N
CR1-1 CR2-1	Diode, Silicon	TR	TJ40A
DS1-1	Lamp: candlebra base 10 Watt, 250 V	GE	S6
J1-1	Connector: type AN	AP	97-3102A-12S-3SW
J2-1 J7-1 J8-1	Connector: type BNC	AP	UG-657/U
J3-1	Connector: type AN	AP	AN-3102A-20-33S
J4-1	Connector: type AN	AP	AN-3102A-20-29S
J5-1	Connector: type AN	AP	97-3102A-14S-7S
L1-1	Inductor: 0.5 millihenry	NC	R-50
L2-1 L3-1	Inductor: torodial, adjustable 4 henry	BUR	AT-4
M1-1	Meter: 50-0-50 microamperes DC	SN	1227
M2-1	Meter: 0-1500 V DC	SN	1329

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

Component Designation	Description	Mfr*	Mfr. Part No.
M3-1	Meter: 0-50 milliamperes DC	SN	1227
P3-1	Connector: type AN	AP	97-3102A-18-8PW
P4-1	Connector: type AN	AP	97-3102A-14S-2P
P6-1	Connector: type AN	AP	97-3102A-20-7PW
R1A/B-1	Resistor: variable, composition Dual 100 K ohms, 2 Watt	AB	JJU1041
R2-1 R3-1	Resistor: fixed, deposited carbon 270 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R4-1	Resistor: variable, composition 2.5 K ohms, 2 Watt	AB	JLU2521
R5-1	Resistor: fixed, deposited carbon 3.3 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R6-1	Resistor: fixed, deposited carbon 47 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R7-1 R23-1 R56-1	Resistor: fixed, composition 47 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R8-1 R13-1 R29-1 R35-1 R65-1 R74-1 R75-1 R83-1 R105-1	Resistor: fixed, composition 100 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R9-1 R18-1 R32-1 R62-1 R68-1 R77-1 R86-1 R94-1	Resistor: fixed, composition 470 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R10-1	Resistor: fixed, deposited carbon 10 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R11-1	Resistor: fixed, deposited carbon 1 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R12-1	Resistor: fixed, composition 10 K ohms, 10%, 1 Watt	O	"Little Devil"
R14-1	Resistor: fixed, composition 27 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R16-1	Resistor: fixed, composition 1.5 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R17-1 R31-1	Resistor: fixed, composition 2.2 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R20-1 R26-1 R33-1 R97-1 R99-1	Resistor: fixed, composition 22 K ohms, 10%, 1 Watt	O	"Little Devil"
R21-1 R58-1 R107-1	Resistor: fixed, composition 15 K ohms, 10%, 1 Watt	O	"Little Devil"
R22-1 R87-1 R90-1 R91-1	Resistor: fixed, composition 150 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See TABLE OF MANUFACTURERS' CODE LETTERS

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R24A/B-1	Resistor: variable, composition Dual 1 M ohms, 2 Watt	AB	JJU1052
R25-1 R61-1 R71-1 R80-1	Resistor: variable, composition 50 K ohms, 2 Watt	AB	JLU5031
R27-1 R28-1 R63-1 R64-1 R72-1 R73-1 R81-1 R82-1	Resistor: fixed, composition 22 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R30-1 R67-1 R76-1 R84-1	Resistor: fixed, composition 220 ohms, 10%, 1/2 Watt	O	"Little Devil"
R34-1 R39-1 R47-1	Resistor: fixed, composition 1 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R36-1	Resistor: fixed, composition 270 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R37-1	Resistor: fixed, composition 220 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R38-1 R40-1 R45-1 R57-1	Resistor: fixed, composition 1 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R41-1	Resistor: fixed, composition 82 K ohms, 10%, 2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R42-1	Resistor: fixed, composition 3.3 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R43-1	Resistor: fixed, composition 56 K ohms, 10%, 1 Watt	O	"Little Devil"
R44-1	Resistor: fixed, wirewound 5 K ohms, 5 Watt	O	"Brown Devil"
R46-1	Resistor: fixed, composition 100 ohms, 10%, 1 Watt	O	"Little Devil"
R48-1	Resistor: variable, composition 100 K ohms, 2 Watt	AB	JU1041
R50-1 R51-1	Resistor: fixed, composition 1500 ohms, 10%, 1 Watt	O	"Little Devil"
R52-1	Resistor: fixed, composition 2.2 K ohms, 10%, 1 Watt	O	"Little Devil"
R53-1	Resistor: fixed, composition 1 K ohms, 10%, 2 Watt	O	"Little Devil"
R55-1 R89-1 R93-1	Resistor: fixed, composition 33 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R59-1 R69-1 R78-1 R85-1 R88-1	Resistor: fixed, composition 1 K ohms, 10%, 1 Watt	O	"Little Devil"
R60-1	Resistor: fixed, composition 33 K ohms, 10%, 1 Watt	O	"Little Devil"
R66-1	Resistor: fixed, composition 56 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R70-1 R79-1	Resistor: fixed, composition 56 K ohms, 10%, 1 Watt	AB	JLU2541
R92-1	Resistor: variable, composition 250 K ohms, 2 Watt	AB	JLU2541
R95-1	Resistor: variable, composition 1 M ohms, 2 Watt	AB	JU1051
R96-1	Resistor: fixed, high voltage 10 M ohms, 15%, 2 Watt	RPC	BBM
R98-1	Resistor: variable, wirewound 10 turn, 300 K ohms, 5 Watt	HE	Series A
R100-1	Resistor: fixed, meter series 3 M ohms, 1%	SN	1329 Shunt
R101-1	Resistor: variable, composition 25 K ohms, 2 Watt	AB	JU2531
R102-1	Resistor: fixed, composition 220 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R103-1	Resistor: variable, composition 10 K ohms, 2 Watt	AB	JU1031
R104-1	Resistor: fixed, composition 2.2 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R106-1	Resistor: fixed, composition 470 ohms, 10%, 2 Watt	O	"Little Devil"
R108-1	Resistor: fixed, composition 4.7 K ohms, 10%, 1 Watt	O	"Little Devil"
S2-1	Switch: toggle, bat handle SPST	C-H	7501K13
S3-1	Switch: rotary, 4 position 2 circuits	CRL	2551

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CONTROL UNIT, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
T2-1 T3-1 T4-1 T6-1	Transformer: interstage	T	A-31X
T5-1	Transformer: output	T	A-51X
V1-1	Tube, electron, 6AN8	GE	6AN8
V3-1 V4-1	Tube, electron, 5814A	GE	5814A
V5-1	Tube, electron, 5751	GE	5751
V6-1	Tube, electron, 2D21	GE	2D21
V7-1	Tube, electron, 12BH7A	GE	12BH7A
V8-1	Tube, electron, 6AG5	GE	6AG5
V9-1 V10-1 V11-1	Tube, electron, 6201	GE	6201
V12-1	Tube, electron, 6C4	GE	6C4
V13-1 thru V26-1	Tube, electron, 0G3/85A2	AX	0G3/85A2

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CRYSTAL CURRENT METER PANEL

(MODELS 402 and 402B)

Component Designation	Description	Mfr*	Mfr. Part No.
C25-2	Capacitor: fixed, metalized paper .1 uf, 200 V DCW	A	P92ZN
M2-2	Meter: 0 - 10 milliamperes DC	SN	1227
P7-3	Connector: type BNC	AP	UG-260/U
S3-2	Switch: toggle DPDT	C-H	7565K5

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: AGC AMPLIFIER

(MODELS 402A and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
C1-2	Capacitor: fixed, disc ceramic .005 uf, 600 V DCW	CRL	DD5022
C2-2 C16-2 C21-2	Capacitor: fixed, disc ceramic .01 uf, 1000 V DCW	CRL	DD1032
C3-2 C6-2	Capacitor: fixed, electrolytic 25 uf, 25 V DCW	A	SRE
C4-2 C8-2 C23-2	Capacitor: fixed, paper .01 uf, 400 V DCW	A	P488N
C5-2 C12-2 C20-2 C25-2	Capacitor: fixed, metalized paper .1 uf, 200 V DCW	A	P92ZN
C7-2	Capacitor: fixed, paper .005 uf, 400 V DCW	A	P488N
C9-2 C24-2	Capacitor: fixed, electrolytic 10-10 uf, 450 V DCW	A	AFH 2-47
C10-2	Capacitor: fixed, metalized paper .01 uf, 400 V DCW	A	P82Z
C11-2	Capacitor: fixed, metalized paper .1 uf, 400 V DCW	A	P82Z
C13-2 C15-2	Capacitor: fixed, metalized paper 1 uf, 200 V DCW	A	P82Z
C14-2	Capacitor: fixed, metalized paper 2 uf, 200 V DCW	A	P82Z
C17-2	Capacitor: fixed, disc ceramic .003 uf, 1000 V DCW	CRL	DD302

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: AGC AMPLIFIER, Continued

(MODELS 402A and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
C18-2 C19-2	Capacitor: fixed, tubular ceramic 300 uuf, 600 V DCW	CRL	D6-301
C22-2	Capacitor: fixed, paper .1 uf, 400 V DCW	A	P488N
CR1-2 CR2-2	Diode: silicon, type TJ20	TR	TJ20
J1-2 J2-2 J4-2	Connector: type BNC	AP	UG-657/U
J3-2	Connector: type BNC	AP	UG-290/U
K1-2	Chopper: SPDT, 6.3 V coil	BC	C-1410
M1-2	Meter: 0-100 microamperes DC	SN	1227
M2-2	Meter: 0-10 milliamperes DC	SN	1227
P1-2	Connector: type AN	AP	97-3102A-14S-6P
R1-2 R2-2	Resistor: fixed, composition 10 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R3-2	Resistor: fixed, composition 270 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R4-2 R9-2	Resistor: fixed, composition 220 K ohms, 10%, 1 Watt	O	"Little Devil"
R5-2 R8-2 R11-2 R21-2	Resistor: fixed, composition 2.2 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R6-2	Resistor: fixed, composition 180 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: AGC AMPLIFIER, Continued

(MODELS 402A and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
R7-2 R30-2	Resistor: fixed, composition 22 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R10-2	Resistor: fixed, composition 56 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R12-2	Resistor: fixed, composition 15 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R13-2	Resistor: variable, composition 250 K ohms, 2 Watt	AB	JU2541
R14-2 R24-2	Resistor: fixed, composition 18 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R15-2	Resistor: fixed, composition 82 K ohms, 10%, 2 Watt	O	"Little Devil"
R16-2 R22-2	Resistor: fixed, composition 560 ohms, 10%, 1/2 Watt	O	"Little Devil"
R17-2 R38-2	Resistor: fixed, composition 470 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R18-2	Resistor: fixed, composition 100 ohms, 10%, 1/2 Watt	O	"Little Devil"
R19-2	Resistor: fixed, composition 12 K ohms, 10%, 2 Watt	O	"Little Devil"
R20-2	Resistor: fixed, composition 330 ohms, 10%, 1/2 Watt	O	"Little Devil"
R23-2	Resistor: fixed, deposited carbon 50 K ohms, 1%, 1/4 Watt	DA	DCH 1/4
R25-2	Resistor: fixed, composition 15 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R26-2 R27-2 R29-2 R39-2	Resistor: fixed, composition 100 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: AGC AMPLIFIER, Continued

(MODELS 402A and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
R28-2	Resistor: fixed, composition 100 K ohms, 10%, 1 Watt	O	"Little Devil"
R31-2 R33-2 R37-2	Resistor: fixed, composition 47 K ohms, 10%, 1 Watt	O	"Little Devil"
R32-2 R34-2 R35-2 R36-2	Resistor: fixed, composition 1 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R40-2 R42-2	Resistor: fixed, composition 4.7 K ohms, 10%, 1 Watt	O	"Little Devil"
R41-2	Resistor: fixed, wirewound 7.5 K ohms, 5%, 10 Watt	O	"Brown Devil"
S1-2	Switch: rotary, single-pole, three position	CRL	PA-2014
S2-2 S3-2 S4-2	Switch: toggle, DPDT	C-H	7565K5
T1-2	Transformer: output	T	JO-22
T2-2	Transformer: output	T	A-51X
V1-2	Tube: electron, type 12AY7	GE	12AY7
V2-2 V4-2	Tube: electron, type 12AT7	GE	12AT7
V3-2	Tube: electron, type 6AW8A	GE	6AW8A

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY

Component Designation	Description	Mfr*	Mfr. Part No.
C1-3 C5-3 C8-3 C12-3 C15-3 C16-3 C19-3 C20-3 C21-3 C24-3 C25-3 C26-3 C29-3 C30-3 C33-3 C34-3 C35-3 C40-3 C41-3 C42-3 C43-3 C44-3 C45-3 C46-3 C47-3	Capacitor: fixed, disc 2000 uuf, 1000 V DCW	CRL	DD202
C2-3 C7-3 C9-3 C10-3 C11-3 C13-3 C18-3 C23-3 C28-3 C32-3 C37-3	Capacitor: fixed, disc 800 uuf, 1000 V DCW	CRL	DD801
C3-3	Capacitor: variable, air dielectric 0-50 uuf	HAM	MAPC-50

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
C6-3	Capacitor: variable, piston 1.2 to 8 uuf	JFD	VC-3G
C14-3 C17-3 C22-3 C27-3 C31-3 C36-3	Capacitor: fixed, disc 470 uuf, 1000 V DCW	CRL	DD-471
C38-3	Capacitor: fixed, disc 1000 uuf, 1000 V DCW	CRL	DD-102
C39-3	Capacitor: fixed, disc 10 uuf, 1000 V DCW	CRL	DD-100
C48-3	Capacitor: electrolytic 8 uf, 450 V DCW	SP	TVA-1704
C49-3	Capacitor: electrolytic 10-10 uf, 450 V DCW	A	PRS
C50A/B/C-3	Capacitor: electrolytic 10-10 uf, 450 V DCW	A	AFH3-31
C52-3	Capacitor: fixed, paper 0.1 uf, 400 V DCW	A	P88N
C54-3	Capacitor: fixed, mica .0062 uf, 600 V DCW	A	1464
C55-3	Capacitor: electrolytic 100 uf, 25 V DCW	A	SRE
C56-3 C57-3	Capacitor: fixed, metalized paper .01 uf, 200 V DCW	A	P123ZG
C58-3	Capacitor: fixed, paper 0.01 uf, 400 V DCW	A	P88N

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
CR1-3	Crystal: diode	SY	1N295
CR2-3	Crystal: diode	TR	1N277
DS1-3 DS2-3 DS3-3	Pilot Lamp Assembly Lamp: candlebra base	JN	.147-103-2 .147-103-3 .147-103-4
F1-3	Fuse: type 8AG, 1/100 amp Fuse Holder: panel mounting	LF B	361.010 HJM
F2-3	Fuse: type 3AG, 1.5 amp Fuse Holder: panel mounting	LF B	31201.5 HKP
F3-3	Fuse: type 3AG, 0.5 amp Fuse Holder: panel mounting	LF B	312.500 HKP
FL1-3	Bolometer Filter: 1000 cps bandpass	SA	FL1-3
J1-3 J2-3 J4-3 J4A-3	Connector: type BNC	AP	UG-657/U
J3-3	Connector: miniature, series M	WA	M9SLRGN
J5-3 J6-3	Connector: type BNC	AP	UG-291/U
J7-3 J8-3 J13-3	Connector: type BNC	AP	UG-290/U
J9-3	Connector: type AN	AP	97-3102A-14S-2S
J11-3	Connector: type AN	AP	97-3102A-18-11S
J12-3	Connector: type AN	AP	97-3102A-12S-3S

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
L1-3	Coil: input	SA	L1-3-402
L2-3	Coil: plate	SA	L2-3-402
L3-3	Coil: plate	SA	L3-3-402
L4-3	Coil: plate	SA	L4-3-402
L5-3	Coil: plate	SA	L5-3-402
L6-3	Coil: plate	SA	L6-3-402
L7-3	Coil: plate	SA	L7-3-402
L8-3	Coil: plate	SA	L8-3-402
L9-3	Coil: plate	SA	L9-3-402
L10-3	Choke: video	SA	L10-3-402
L11-3	Choke: filter	T	C11-X
LN1-3	Coil: neutralizing	SA	LN1-3
P2-3 P4-3 P4A-3	Connector: type BNC	AP	UG-260/U
P3-3	Connector: miniature, series M	WA	M9PLSH19S
P10-3	Connector: power input	AP	61M
P13-3	Connector: type BNC	AP	UG-88/U
R1-3	Resistor: fixed, composition 100 ohms, 10%, 1/2 Watt	O	"Little Devil"
R2-3	Resistor: fixed, composition 150 ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R3-3 R5-3 R6-3 R11-3 R12-3 R17-3 R18-3 R23-3 R24-3 R29-3	Resistor: fixed, composition 470 ohms, 10%, 1/2 Watt	O	"Little Devil"
R4-3	Resistor: fixed, composition 2.2 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R7-3 R13-3 R19-3 R25-3 R30-3 R38-3 R39-3 R40-3 R41-3	Resistor: fixed, composition 10 ohms, 10%, 1/2 Watt	O	"Little Devil"
R8-3 R14-3 R20-3 R26-3 R43-3 R44-3 R45-3 R46-3	Resistor: fixed, composition 47 ohms, 10%, 1/2 Watt	O	"Little Devil"
R9-3 R15-3 R21-3 R27-3	Resistor: fixed, composition 120 ohms, 10%, 1/2 Watt	O	"Little Devil"
R10-3	Resistor: fixed, composition 1.8 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R16-3 R22-3 R28-3 R54-3	Resistor: fixed, composition 3.9 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R32-3	Resistor: fixed, composition 180 ohms, 10%, 1/2 Watt	O	"Little Devil"
R33-3	Resistor: fixed, composition 12 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R34-3	Resistor: fixed, composition 22 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R35-3	Resistor: fixed, composition 2.7 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R36-3	Resistor: fixed, composition 6.8 K ohms, 10%, 2 Watt	O	"Little Devil"
R37-3	Resistor: fixed, composition 10 K ohms, 10%, 2 Watt	O	"Little Devil"
R42-3	Resistor: fixed, composition 1 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R47-3 R49-3	Resistor: fixed, composition 47 K ohms, 10%, 1 Watt	O	"Little Devil"
R48-3	Resistor: variable, composition 50 K ohms, 2 Watt	AB	JLU5031
R50-3	Resistor: fixed, composition 68 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R51-3	Resistor: fixed, composition 47 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R55-3	Resistor: fixed, composition 100 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: IF AMPLIFIER AND POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R56-3	Resistor: fixed, deposited carbon 4.5 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R57-3	Resistor: fixed, deposited carbon 180 K ohms, 1%, 1/2 Watt	DA	DCSH1/2
R58-3	Resistor: fixed, composition 220 ohms, 10%, 1/2 Watt	O	"Little Devil"
RFC1-3 thru RFC13-3	Radio Frequency Choke	SA	RFC-3-402
S1-3	Switch: toggle, SPST	C-H	7501K13
S2-3	Switch: toggle, SPDT	C-H	7505K4
T1-3	Transformer: plate power	T	R-12B
T2-3	Transformer: filament	T	F-16X
T3-3	Transformer: filament	T	F-13X
V1-3	Tube: electron, type 6BC4	TE	6BC4
V2-3 V3-3 V4-3 V5-3 V6-3 V7-3	Tube: electron, type 6CB6	TE	6CB6
V8-3	Tube: electron, type 5Y3GT	GE	5Y3GT
V9-3 V10-3	Tube: electron, type 5687	GE	5687
V11-3	Tube: electron, type 12AX7	GE	12AX7
V12-3	Tube: electron, type 5651	GE	5651
V13-3	Tube: electron, type 6X4	GE	6X4
V14-3	Tube: electron, type OB2	GE	OB2

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: RF UNIT

(MODELS 402 and 402A)

Component Designation	Description	Mfr*	Mfr. Part No.
AT1-4	Attenuator	SAN	Tri Plate
B1-4	Blower Assembly	L-R	8347
C1-4	Capacitor: electrolytic 4000 uf, 15 V DCW	CD	FB1540
C2-4	Capacitor: electrolytic 25 uf, 150 V DCW	A	SRE
CR1-4	Selenium Rectifier: bridge	ST	D-52
J8-4 J21-4	Connector: type BNC	AP	UG-291/U
P1-4 P2-4 P3-4 P6-4	Connector: type N	AP	UG-18B/U
P7-4 P9-4	Connector: type BNC	AP	UG-88/U
P22-4	Connector: type AN	AP	97-3102A-20-7P
P23-4	Connector: type AN	AP	97-3102A-12S-3P
R1-4	Resistor adjustable WW 2-1/2-25W	O	"Brown Devel"
T1-4	Transformer: filament Pri 115 V, 60 cps, sec. 9 V, 2.8 amp	T	11546
V1-4	Tube: electron	R	QK518

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: RF UNIT

(MODELS 402B and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
AT1-4	Attenuator	SAN	Tri Plate
B1-4	Blower Assembly	L-R	8347
C1-4	Capacitor: electrolytic 4000 uf, 15 V DCW	CD	FB1540
C2-4	Capacitor: electrolytic 25 uf, 150 V DCW	A	SRE
CR1-4	Selenium Rectifier: bridge	ST	D-52
F1-4	Fuse: type 3AG, 1/16 amp Fuse Holder, panel mounting	LF B	312.062 HKP
J4-4 J5-4 J5A-4 J12-4	Connector: type N	AP	UG-19B/U
J8-4 J18-4 J18A-4 J19-4 J21-4	Connector: type BNC	AP	UG-291/U
J17A-4	Connector: type N	AP	UG-20B/U
J25-4	Connector: miniature, series M	WA	M4SLSH10
P1-4 P2-4 P3-4 P4-4 P5-4 P6-4 P10-4 P11-4 P16A-4	Connector: type N	AP	UG-18B/U

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: RF UNIT, Continued
(MODELS 402B and 402C)

Component Designation	Description	Mfr*	Mfr. Part No.
P7-4 P9-4 P16-4 P17-4 P17B-4 P18-4 P19-4	Connector: type BNC	AP	UG-88/U
P22-4	Connector: type AN	AP	97-3102A-20-7P
P23-4	Connector: type AN	AP	97-3102A-12S-3P
P24-4	Connector: type AN	AP	97-3102A-18-4PW
P25-4	Connector: miniature, Series M	WA	M4PLRN
R1-4	Resistor: adjustable, wirewound 2 ohms, 25 Watt	O	"Brown Devil"
R2-4	Resistor: variable, composition 1 K ohms, 2 Watt	AB	JLU1021
R3-4	Resistor: adjustable, wirewound 10 K ohms, 10 Watt	O	"Brown Devil"
R4-4	Resistor: fixed, composition 1 K ohms, 2 Watt	O	"Little Devil"
S1-4	Switch: toggle, DPST	C-H	7561K4
T1-4	Transformer: filament Pri 115 V, 60 cps, sec. 9 V, 2.8 amp	T	11546
V1-4	Tube: electron	R	QK518
V2-4	Tube: electron	RCA	5675

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: LOW VOLTAGE AND COMPARATOR AMPLIFIER POWER SUPPLY

Component Designation	Description	Mfr*	Mfr. Part No.
C1-5	Capacitor: Oil filled, 8-8-4 uf 650 V DCW	SP	SP-CSF481313-20
C2-5	Capacitor: fixed, paper 0.005 uf, 20%, 400 V DCW	A	P88N
C3-5	Capacitor: disc 150 uuf, 1 K V DCW	CRL	MD151
C4-5	Capacitor: fixed, metalized paper 0.1 uf, 20%, 400 V DCW	A	P92ZN
C5-5	Capacitor: fixed, metalized paper 0.5 uf, 20%, 400 V DCW	A	P92ZN
C6-5	Capacitor: electrolytic 1000 uf, 12 V DCW	CD	FB1210
C7-5	Capacitor: electrolytic 10-10 uf, 500 V DCW	A	AFH2-67
C8-5 C9-5	Capacitor: electrolytic 20 uf, 500 V DCW	A	PRS
C10-5	Capacitor: fixed, paper 0.05 uf, 600 DCW	A	P82Z
C11-5 C12-5	Capacitor: electrolytic 80 uf, 450 V DCW	A	E450
CR1-5	Rectifier: selenium bridge	F	1016
F1-5	Fuse: type 3AG, 2 A Fuse Holder: panel mounting	LF B	312002 HKP
F2-5	Fuse: type 3AG, 1.5 A Fuse Holder: panel mounting	LF B	31201.5 HKP
J1-5	Connector: type AN	AP	97-3102A-18-8SW

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: LOW VOLTAGE AND COMPARATOR AMPLIFIER

POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
J3-5	Connector: type AN	AP	97-3102A-14S-6S
J4-5	Connector: type AN	AP	97-3102A-18-4SW
L1-5	Choke: 6 henry, 200 ma	T	C-14X
L2-5 L3-5	Choke: 10 henry, 90 ma	T	C-7X
P2-5	Connector: type AN	AP	97-3102A-18-8P
R1-5	Resistor: fixed, composition 68 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R2-5 R15-5	Resistor: fixed, composition 47 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R3-5 R11-5	Resistor: fixed, composition 120 K ohms, 10%, 1 Watt	O	"Little Devil"
R4-5	Resistor: fixed, composition 330 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R5-5 R12-5	Resistor: fixed, wirewound 15 K ohms, 10 Watt	O	"Brown Devil"
R6-5 R7-5	Resistor: fixed, composition 470 ohms, 10%, 1/2 Watt	O	"Little Devil"
R8-5 R9-5	Resistor: fixed, composition 33 ohms, 10%, 1 Watt	O	"Little Devil"
R10-5	Resistor: fixed, composition 470 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R13-5	Resistor: fixed, composition 680 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R14-5	Resistor: fixed, composition 33 ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: LOW VOLTAGE AND COMPARATOR AMPLIFIER

POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R16-5 R27-5	Resistor: fixed, composition 100 K ohms, 10%, 1 Watt	O	"Little Devil"
R17-5	Resistor: fixed, composition 4.7 M ohms, 10%, 1 Watt	O	"Little Devil"
R18-5	Resistor: fixed, composition 47 K ohms, 10%, 2 Watt	O	"Little Devil"
R19-5	Resistor: variable, composition 5 K ohms, 10%, 2 Watt	AB	JLU5021
R20-5	Resistor: fixed, composition 15 K ohms, 10%, 1 Watt	O	"Little Devil"
R21-5 R23-5	Resistor: fixed, composition 1 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R22-5	Resistor: fixed, composition 270 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R24-5 R25-5	Resistor: fixed 400 K ohms, 1%, 1 Watt	CC	NR25
R26-5 R28-5	Resistor: fixed 500 K ohms, 1%, 1 Watt	CC	NR25
R29-5	Resistor: fixed, wirewound 4 K ohms, 10 Watt	O	"Brown Devil"
R30-5	Resistor: fixed, wirewound 1 K ohms, 5 Watt	O	"Brown Devil"
R31-5 R33-5	Resistor: fixed 800 K ohms, 1%, 1 Watt	CC	NR25
R32-5	Resistor: fixed, wirewound 25 K ohms, 10 Watt	O	"Brown Devil"
S1-5	Switch: toggle, bat handle SPST	C-H	7501K13

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: LOW VOLTAGE AND COMPARATOR AMPLIFIER
POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
T1-5	Transformer: plate power 400-0-400 V at 200 ma 5 V at 3 amp, 6.3 V at 6 amp	T	R-21B
T2-5 T7-5	Transformer: filament 6.3 V at 3 amp	T	F-16X
T3-5	Transformer: filament 6.3 V at 6 amp	T	F-18X
T4-5	Transformer: filament 6.3 V at 1.2 amp	T	F-14X
T5-5	Transformer: plate power 350-0-350 V at 90 ma 5 V at 3 amp, 6.3 V at 3.5 amp	T	R-11B
T6-5	Transformer: filament 6.3 V at 0.6 amp	T	F-13X
V1-5	Tube: electron, type 5U4GA	GE	5U4GA
V2-5	Tube: electron, type 6080	TE	6080
V3-5	Tube: electron, type 5751	GE	5751
V4-5	Tube: electron, type 5651	GE	5651
V5-5	Tube: electron, type 5V4GA	GE	5V4GA
V6-5	Tube: electron, type 6BX7	GE	6BX7
V7-5 V8-5	Tube: electron, type 12AX7	GE	12AX7
V9-5	Tube: electron, type 6X4	GE	6X4
V10-5 V11-5	Tube: electron, type OA2	GE	OA2

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY

Component Designation	Description	Mfr*	Mfr. Part No.
C1-6	Capacitor: fixed, bathtub paper 2 x 0.25 uf, 600 V DCW	A	JP30MT
C2-6	Capacitor: fixed, mica 1500 uuf, 500 V DCW	A	1467LS
C3-6	Capacitor: fixed, paper 0.1 uf, 400 V DCW	A	P88N
C4-6 C5-6 C6-6	Capacitor: fixed, ceramic tubular 47 uuf, 500 V DCW	A	CI
C7-6	Capacitor: fixed, oil-filled paper 4.0 uf, 2500 V DCW	A	JP09MSB
C8-6	Capacitor: fixed, oil-filled paper 2.0 uf, 2500 V DCW	A	JP09MSB
C9-6 C10-6	Capacitor: fixed, bathtub electrolytic 50 uf, 25 V DCW	A	BT25
C11-6	Capacitor: fixed, paper 0.001 uf, 400 V DCW	A	P88N
C12-6	Capacitor: fixed, electrolytic 50 uf, 450 V DCW	A	PRS
C13-6	Capacitor: fixed, paper 0.01 uf, 400 V DCW	A	P88N
C14-6	Capacitor: fixed, electrolytic 20 uf, 450 V DCW	A	PRS
C15-6	Capacitor: fixed, electrolytic 8 uf, 700 V DCW	A	PRS
C16-6	Capacitor: fixed, electrolytic 20 uf, 500 V DCW	A	PRS
C17-6	Capacitor: fixed, electrolytic 50 uf, 350 V DCW	A	PRS

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
C18-6	Capacitor: fixed, oil-filled paper 2.0 uf, 2000 V DCW	A	JP09MSB
C19-6	Capacitor: fixed, paper .05 uf, 400 V DCW	A	P88N
CR1-6	Diode: silicon	TR	TJ-20
F1-6	Fuse: type 3AG, 3A	LF	312003
F2-6	Fuse Holder: panel mounting	B	HKP
J1-6	Connector: type BNC	AP	UG-290/U
J2-6	Connector: type AN	AP	97-3102A-14S-7S
J3-6	Connector: type AN	AP	97-3102A-18-8S
J5-6	Connector: type AN	AP	97-3102A-20-7SW
J6-6	Connector: type AN	AP	97-3102A-20-7S
K1-6	Relay: DPDT, 115 V AC coil	PB	PS11A
K2-6	Relay: thermostatic delay	AM	115N060T
K3-6	Relay: DPDT 115 V AC coil	PB	KA11A
L1-6	Choke: filter 15 henry, 75 ma	T	15049
L2-6	Choke: filter 10 henry, 90 ma	T	C-7X
NB1-6	Bulb: neon	GE	NE-2
P4-6	Connector: type AN	AP	97-3102A-18-11P

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R1-6 R2-6 R3-6 R8-6 R38-6 R46-6	Resistor: fixed, metal film 500 K ohms, 1%, 1 Watt	CC	NR-25
R4-6 R5-6	Resistor: fixed, metal film 95 K ohms, 1%, 1 Watt	CC	NR-25
R6A/B-6 R7A/B-6	Resistor: fixed, metal film 800 K ohms, 1%, 1 Watt	CC	NR-25
R9-6 R11-6 R36-6 R37-6 R44-6 R45-6	Resistor: fixed, metal film 400 K ohms, 1%, 1 Watt	CC	NR-25
R10-6 R12-6	Resistor: fixed, composition 82 K ohms, 10%, 2 Watt	O	"Little Devil"
R13-6	Resistor: fixed, composition 180 K ohms, 10%, 2 Watt	O	"Little Devil"
R14-6	Resistor: fixed, composition 15 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R15-6	Resistor: fixed, composition 33 K ohms, 10%, 2 Watt	O	"Little Devil"
R16-6	Resistor: fixed, composition 2.2 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R17-6	Resistor: fixed, composition 3.3 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R18-6	Resistor: fixed, composition 390 K ohms, 10%, 2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
R19-6	Resistor: fixed, composition 22 K ohms, 10%, 2 Watt	O	"Little Devil"
R20-6	Resistor: fixed, composition 100 K ohms, 10%, 1 Watt	O	"Little Devil"
R21-6 R22-6 R30-6	Resistor: fixed, wirewound 100 K ohms, 50 Watt	SP	50KT
R23-6 R33-6 R34-6	Resistor: fixed, composition 1 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R24-6	Resistor: fixed, composition 22 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R25-6	Resistor: fixed, composition 180 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R26-6	Resistor: fixed, composition 27 K ohms, 10%, 2 Watt	O	"Little Devil"
R27-6	Resistor: fixed, metal film 600 K ohms, 1%, 1 Watt	CC	NR-25
R28-6	Resistor: variable, composition 250 K ohms, 10%, 2 Watt	AB	JU2541
R29-6	Resistor: fixed, composition 1 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R31-6	Resistor: fixed, high voltage 5.0 M ohms, 15%, 2 Watt	RPC	BBM
R32-6	Resistor: fixed, high voltage 2.5 M ohms, 15%, 2 Watt	RPC	BBM
R35-6	Resistor: fixed, composition 820 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY, Continued

Component Description	Description	Mfr*	Mfr. Part No.
R39-6	Resistor: variable, composition 100 K ohms, 10%, 2 Watt	AB	JU1041
R40-6	Resistor: fixed, wirewound 15 K ohms, 10 Watt	O	"Brown Devil"
R41-6 R42-6 R43-6	Resistor: fixed, wirewound 7.5 K ohms, 10 Watt	O	"Brown Devil"
R47-6	Resistor: fixed, composition 47 K ohms, 10%, 1 Watt	O	"Little Devil"
T1-6	Transformer: plate power 1500-400-0-400-1500 V AC	UTC	CG-303
T2-6	Transformer: filament 10 V AC, 10 A, 1500 V Test 2.5 V AC, 10 A, 7500 V Test	T	F-27U
T3-6 T4-6 T5-6 T6-6	Transformer: filament 6.3 V AC, 2 A, 5000 V Test	T	F-51X
V1-6 V2-6	Tube: electron, type 836	WE	836
V3-6	Tube: electron, type 813	GE	813
V4-6 V5-6	Tube: electron, type 5Y3GT	GE	5Y3GT
V6-6	Tube: electron, type 12BH7A	GE	12BH7A
V7-6	Tube: electron, type 6626/0A2WA	CBS	6626/0A2WA
V8-6 V9-6 V11-6	Tube: electron, type 12AX7	GE	12AX7
V10-6	Tube: electron, type 6BQ6 GA	GE	6BQ6 GA

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: CARCINOTRON POWER SUPPLY, Continued

Component Designation	Description	Mfr*	Mfr. Part No.
V12-6 V13-6 V14-6 V15-6	Tube: electron, type OG3/85A2	AX	OG3/85A2
V16-6	Tube: electron, type 6SU7GTY	TE	6SU7GTY
V17-6 V18-6	Tube: electron, type 12AY7	GE	12AY7
V19-6	Tube: electron, type 12AT7	GE	12AT7

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: MONITOR OSCILLOSCOPE

Component Designation	Description	Mfr*	Mfr. Part No.
C1-8 C3-8	Capacitor: fixed, metalized paper .01 uf, 400 V DCW	A	P82Z
C2-8	Capacitor: fixed, three-section elec. 10-10-10 uf, 450 V DCW	A	AFH3-30
C4-8 C6-8 C7-8	Capacitor: fixed, metalized paper .1 uf, 200 V DCW	A	P82Z
C8-8	Capacitor: fixed, bathtub paper 2 x .25 uf, 1000 WV DC	A	JP1030M
CR1-8 CR2-8	Diode, silicon	TR	TJ-20
DS1-8 DS2-8	Bulb: incandescent, 6.3 V, 150 ma bayonet base	GE	47
F1-8	Fuse: type 3AG .5A Fuse Holder: panel mounting	LF B	312.500 HKP
P1-8	Connector: type AN	AP	AN-3102A-20-29P
P2-8	Connector: type AN	AP	AN-3102A-20-33P
R1-8 R5-8	Resistor: fixed, composition 330 K ohms, 10%, 1 Watt	O	"Little Devil"
R2-8	Resistor: fixed, composition 560 ohms, 10%, 1/2 Watt	O	"Little Devil"
R3-8	Resistor: variable, composition 25 K ohms, 10%, 2 Watt	AB	JU2531
R4-8 R8-8	Resistor: fixed, composition 4.7 M ohms, 10%, 1/2 Watt	O	"Little Devil"
R6-8	Resistor: fixed, composition 8.2 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

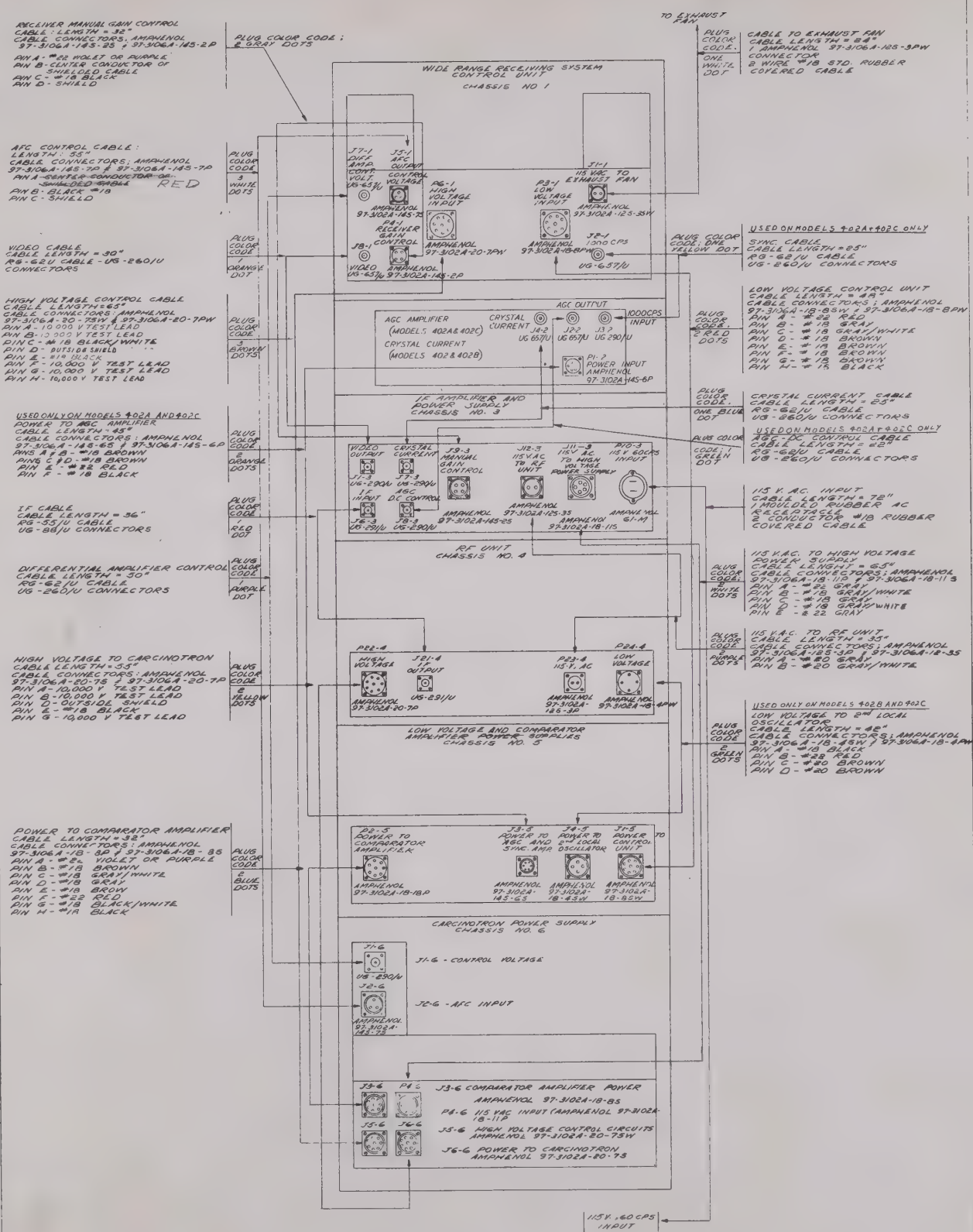
Component Designation	Description	Mfr*	Mfr. Part No.
R7-8	Resistor: fixed, composition 2.7 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R9-8 R10-8 R30-8 R31-8	Resistor: fixed, composition 180 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R11-8 R32-8 R33-8	Resistor: fixed, composition 47 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R12-8	Resistor: variable, composition 100 K ohms, 10%	W	
R13-8 R15-8	Resistor: fixed, composition 820 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R14-8	Resistor: fixed, composition 120 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R16-8	Resistor: variable, composition 500 K ohms, 10%	W	
R17-8	Resistor: fixed, carbon film 90 K ohms, 1%, 1/4 Watt	DA	DCH1/4
R18-8	Resistor: fixed, carbon film 9 K ohms, 1%, 1/4 Watt	DA	DCH1/4
R19-8	Resistor: fixed, carbon film 1 K ohms, 1%, 1/4 Watt	DA	DCH1/4
R20-8	Resistor: fixed, composition 270 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R21-8	Resistor: variable, composition 50 K ohms, 10%	W	RVD003-015
R22-8 R23-8 R40-8	Resistor: fixed, composition 2.2 K ohms, 10%, 1/2 Watt	O	"Little Devil"

* See "TABLE OF MANUFACTURERS' CODE LETTERS"

SUBUNIT: MONITOR OSCILLOSCOPE, Continued

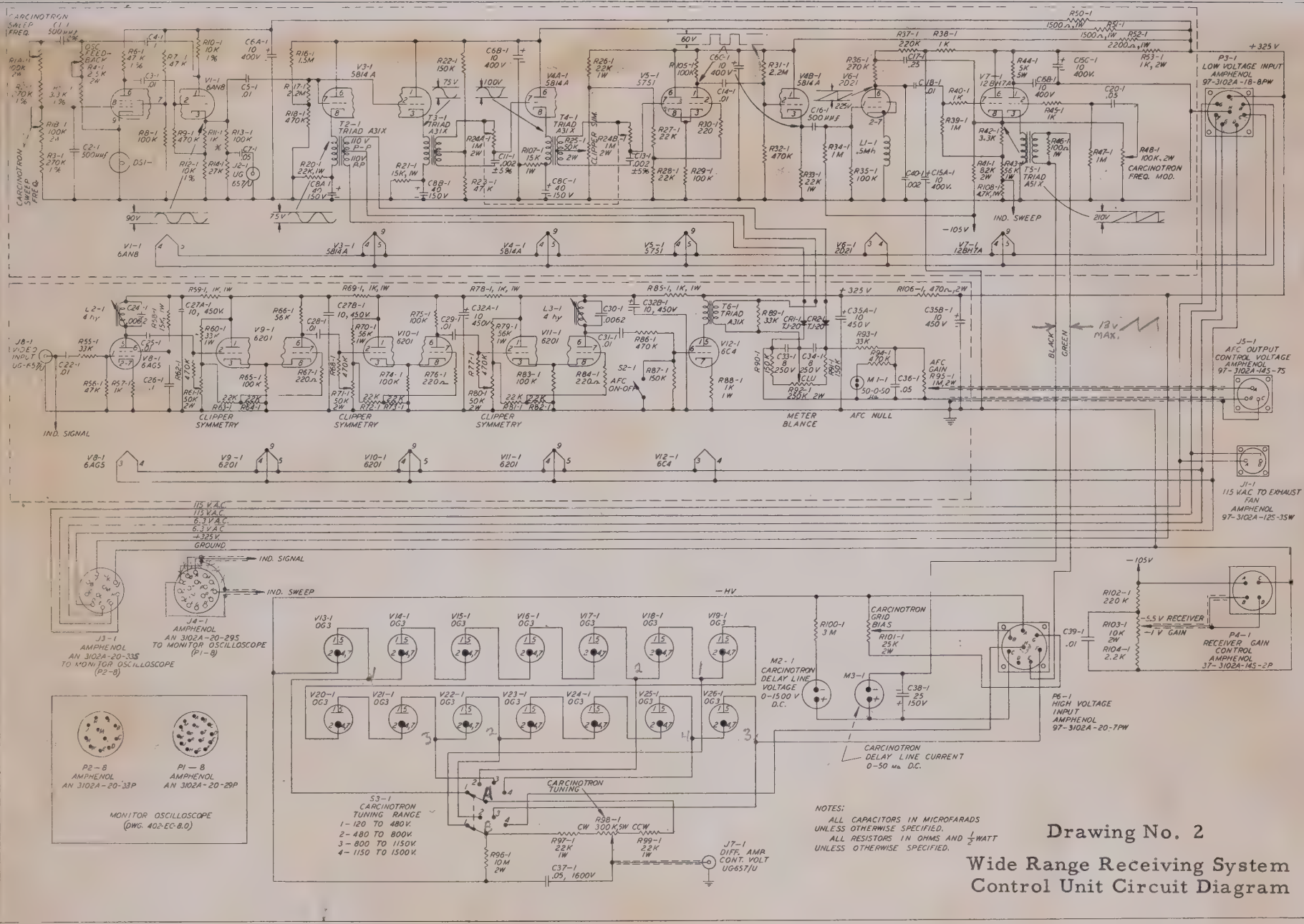
Component Designation	Description	Mfr*	Mfr. Part No.
R24-8 R36-8	Resistor: fixed, composition 56 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R25-8 R26-8	Resistor: variable, composition 250 K ohms, 10%	W	RVD003-002
R27-8	Resistor: fixed, composition 22 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R28-8	Resistor: fixed, composition 390 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R29-8	Resistor: variable, composition 500 K ohms, 10%, 2 Watt	AB	JU5041
R34-8	Resistor: fixed, wirewound 1.2 ohms, 10%, 1/2 Watt	IRC	BW-1/2
R35-8	Resistor: fixed, composition 10 ohms, 10%, 1/2 Watt	O	"Little Devil"
R37-8	Resistor: fixed, composition 33 K ohms, 10%, 1/2 Watt	O	"Little Devil"
R38-8 R39-8	Resistor: fixed, composition 47 K ohms, 10%, 2 Watt	O	"Little Devil"
R41-8	Resistor: fixed, composition 100 K ohms, 10%, 1/2 Watt	O	"Little Devil"
S1-8	Switch: rotary, 2 pole, 6 position shorting, stealite insulation	CRL	PA-2002
T1-8	Transformer: plate and filament power	W	LPU020
V1-8 V2-8 V4-8	Tube: electron, type 12AY7	GE	12AY7
V3-8	Tube: cathode ray, type 3SP1	W	3SP1
V5-8	Tube: electron, type 1V2	RCA	1V2

* See "TABLE OF MANUFACTURERS' CODE LETTERS"


WIDE RANGE RECEIVING SYSTEM CONTROL UNIT CHASSIS NO. 1
IF AMPLIFIER AND POWER SUPPLY CHASSIS NO. 3
RF UNIT CHASSIS NO. 4
LOW VOLTAGE AND COMPARATOR AMPLIFIER POWER SUPPLIES CHASSIS NO. 5
CARCINOTRON POWER SUPPLY CHASSIS NO. 6
TO EXHAUST FAN
AGC OUTPUT
115 VAC TO EXHAUST FAN
J1-6 - CONTROL VOLTAGE
J2-6 - AFC INPUT
J3-6 COMPARATOR AMPLIFIER POWER AMPHENOL 97-3102A-18-8S
P4-6 115 VAC INPUT (AMPHENOL 97-3102A-18-11P
J5-6 HIGH VOLTAGE CONTROL CIRCUITS AMPHENOL 97-3102A-20-7SW
J6-6 POWER TO CARCINOTRON AMPHENOL 97-3102A-20-7S
115 V., 60 CPS INPUT

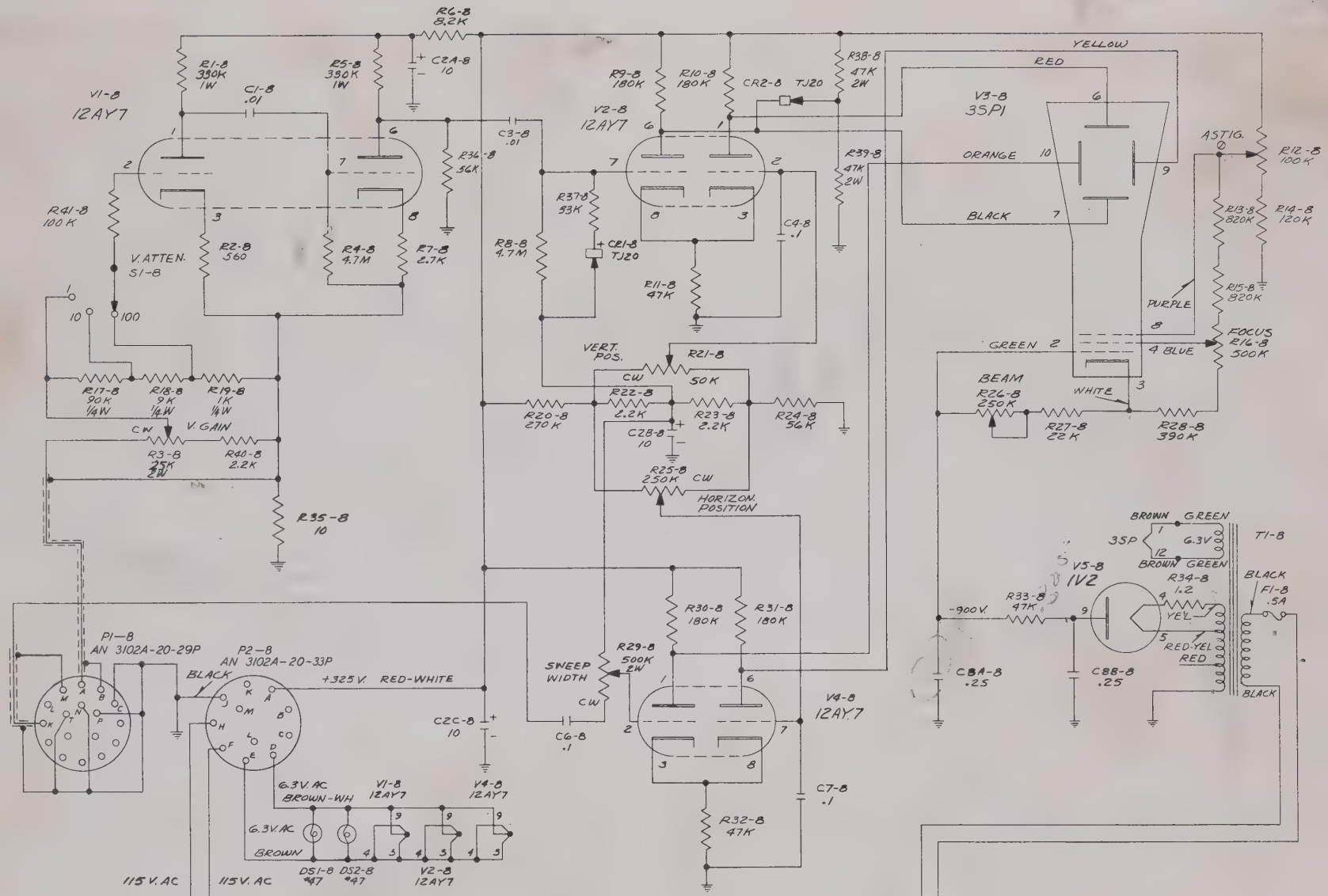
Drawing No. 1

Wide Range Receiving System
Cabling Diagram



Drawing No. 2

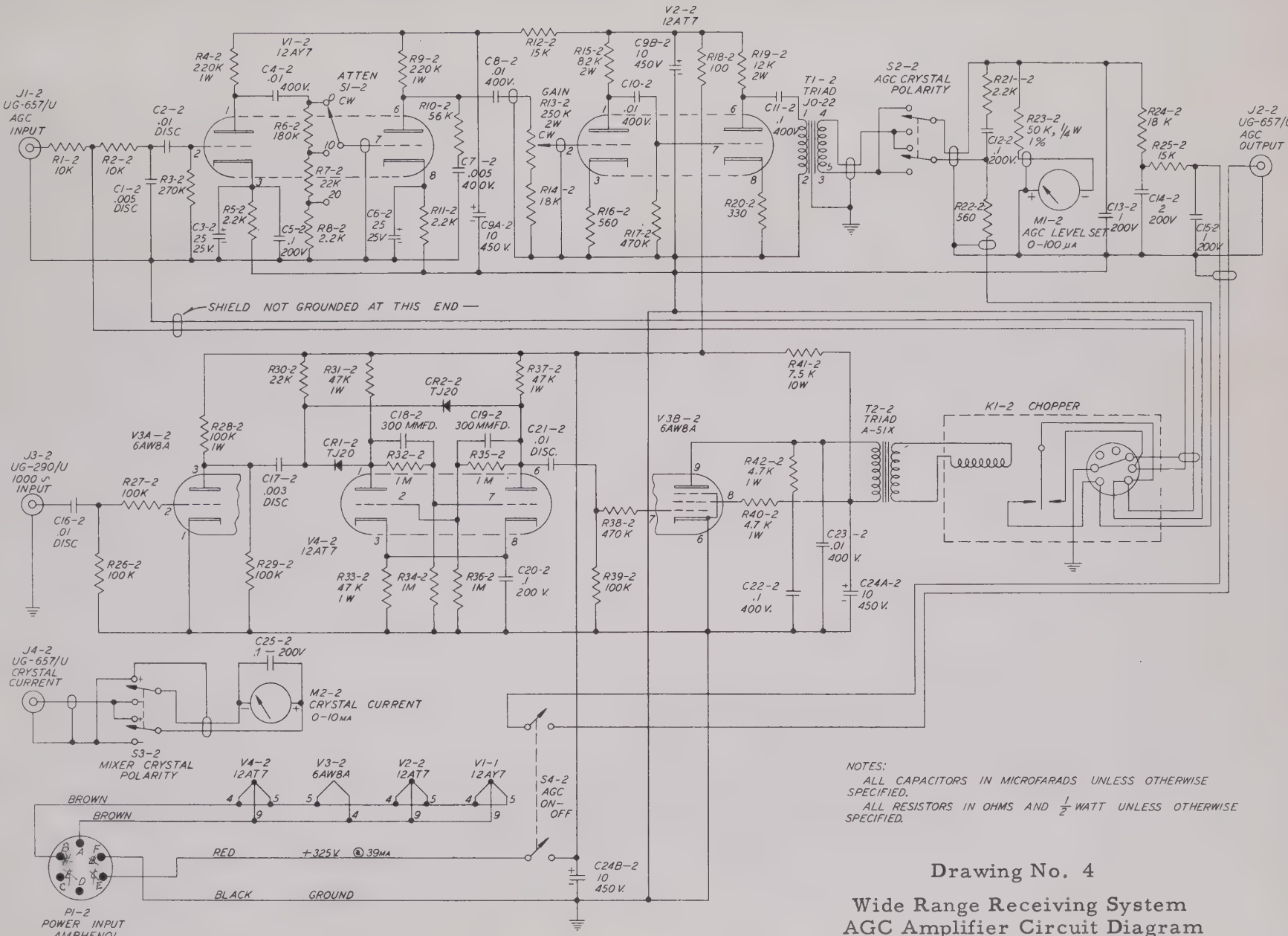
Wide Range Receiving System
Control Unit Circuit Diagram



NOTES:
ALL RESISTORS IN OHMS AND 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

Drawing No. 3

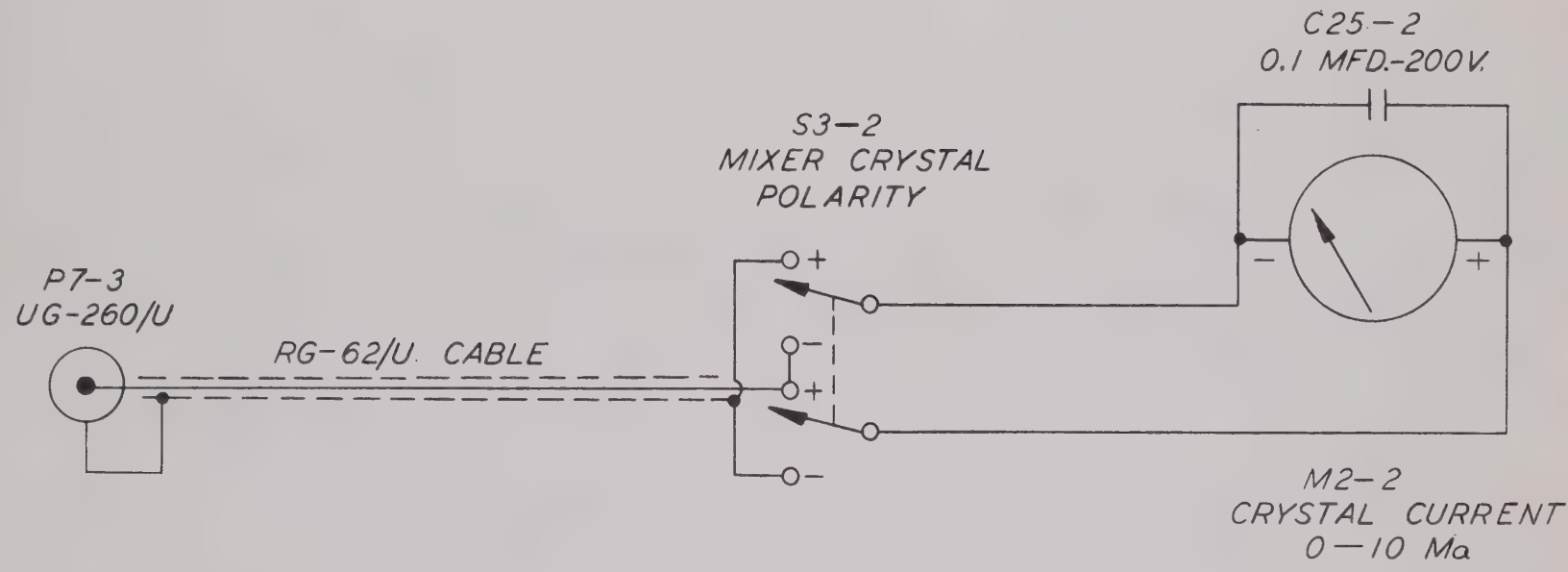
Wide Range Receiving System
Monitor Oscilloscope Circuit Diagram



NOTES:
ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS IN OHMS AND 1/2 WATT UNLESS OTHERWISE SPECIFIED.

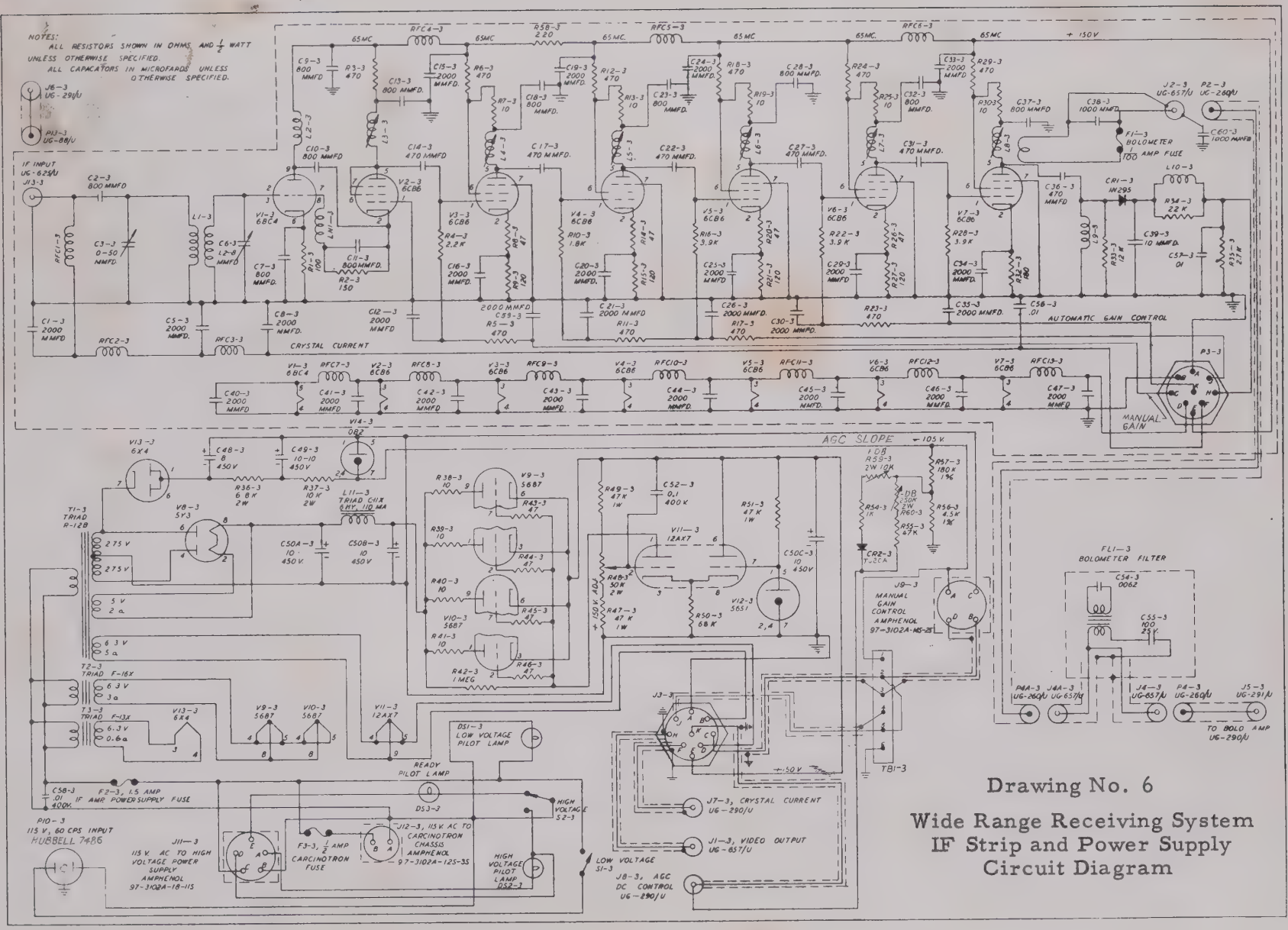
Drawing No. 4

Wide Range Receiving System AGC Amplifier Circuit Diagram (Models 402A and 402C)



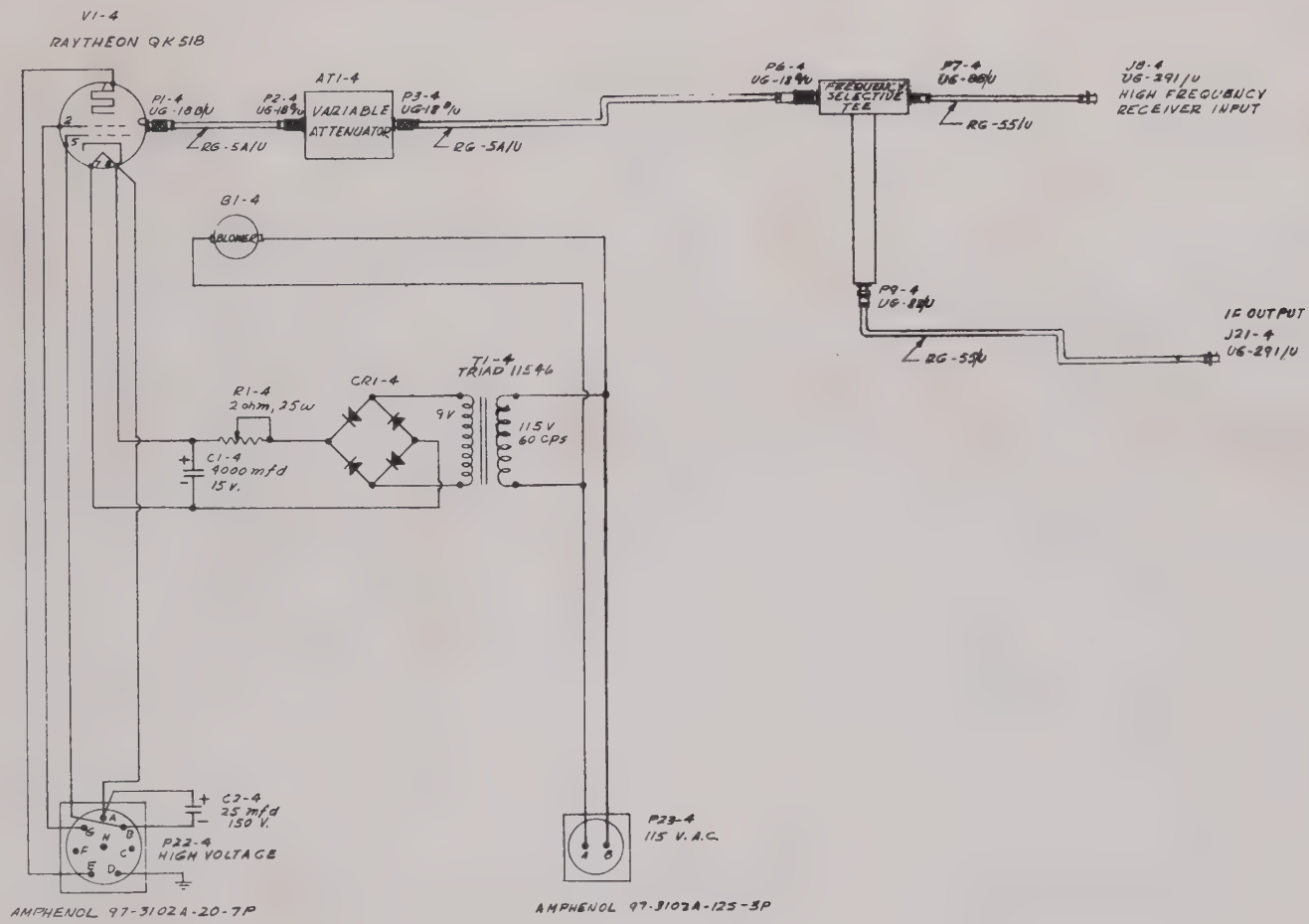
Drawing No. 5

Wide Range Receiving System
Crystal Current Meter Panel Circuit Diagram
(Models 402 and 402B)



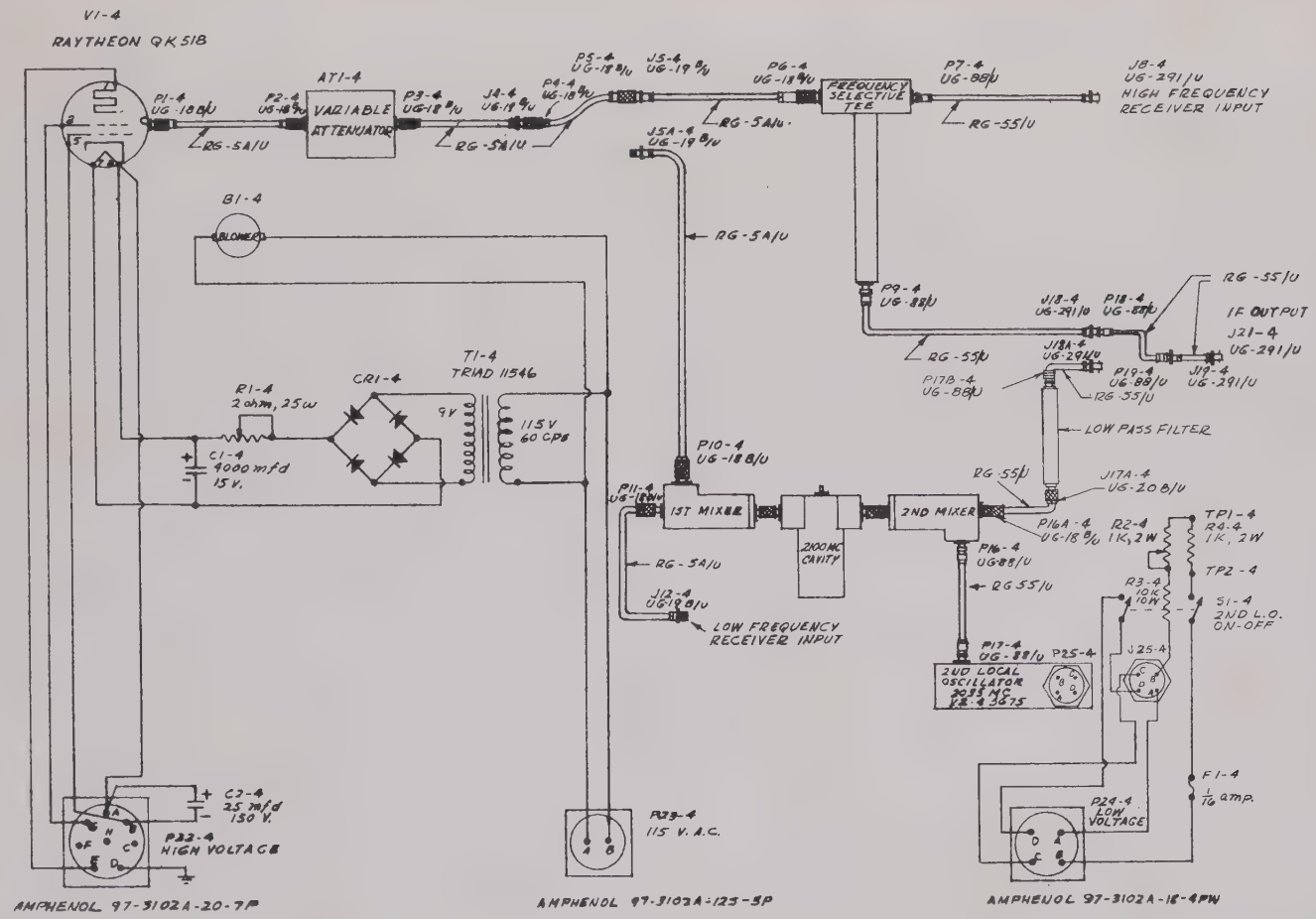
Drawing No. 6

Wide Range Receiving System IF Strip and Power Supply Circuit Diagram



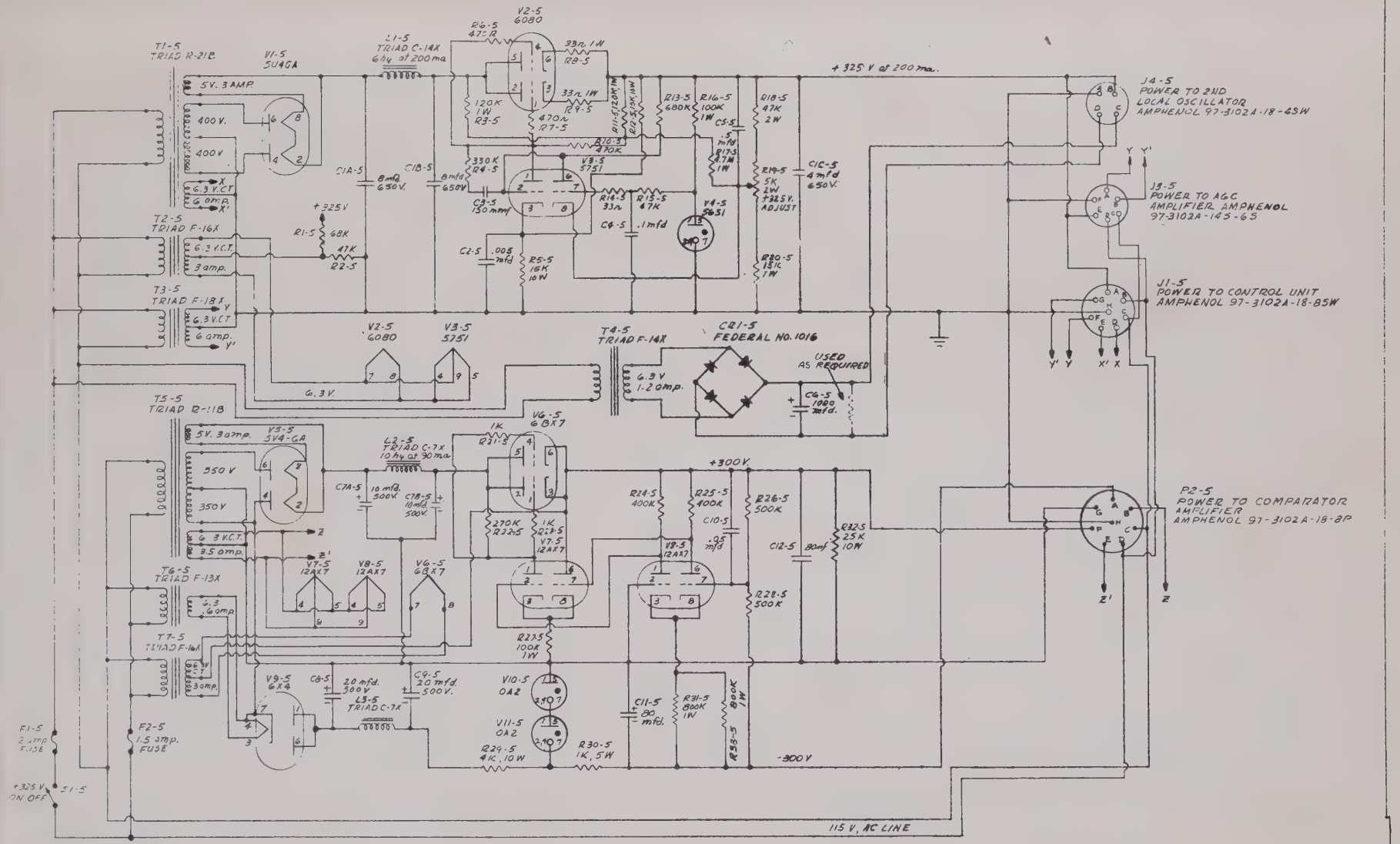
Drawing No. 7

Wide Range Receiving System
High Frequency RF Unit Circuit Diagram
(Models 402 and 402A)



Drawing No. 8

Wide Range Receiving System
High and Low Frequency RF Unit Circuit Diagram
(Models 402B and 402C)



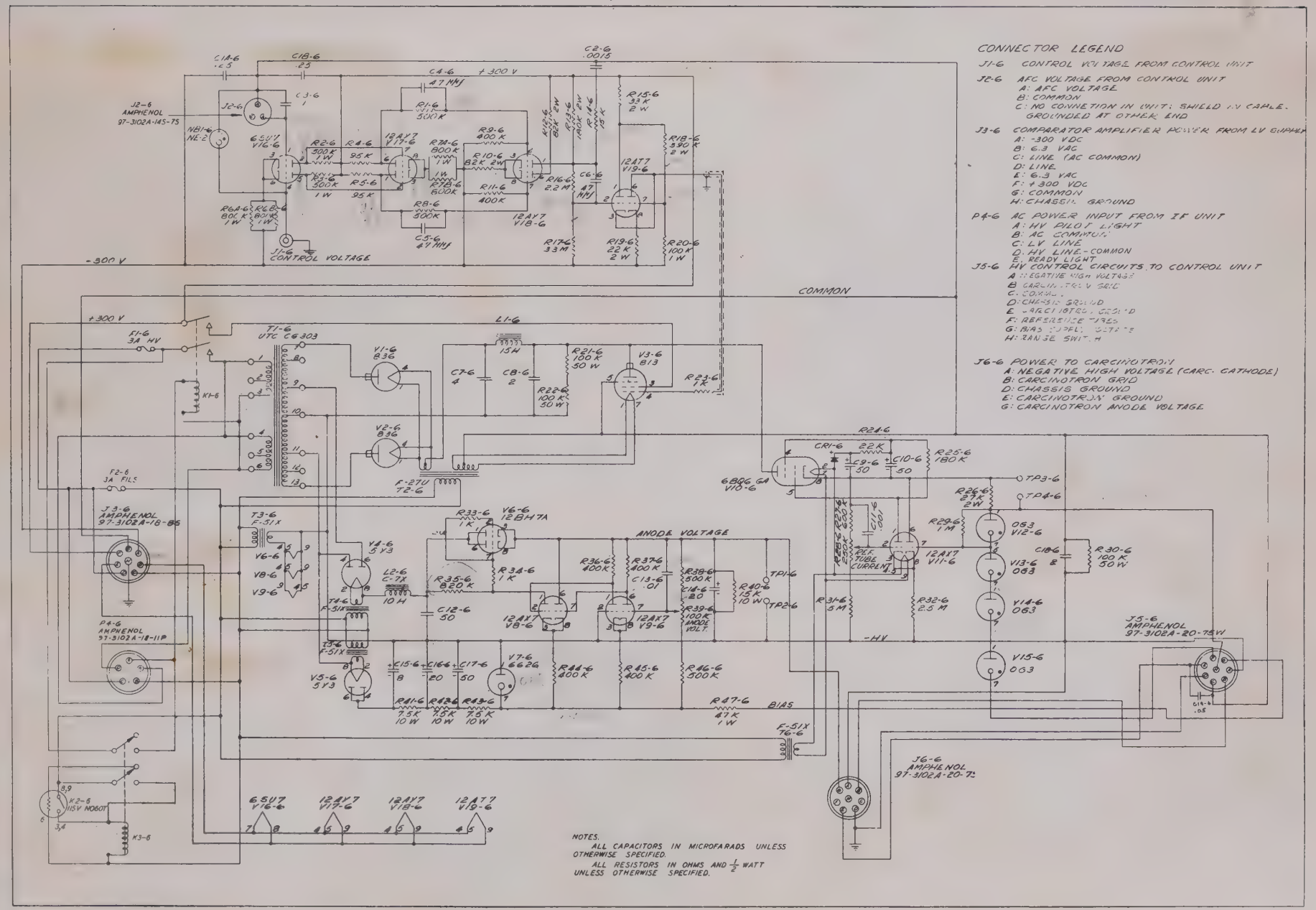
NOTES

ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE SPECIFIED.

ALL RESISTORS IN OHMS AND ½ WATT UNLESS OTHERWISE SPECIFIED.

Drawing No. 9

Wide Range Receiving System
Low Voltage and Comparator Amplifier
Power Supply Circuit Diagram



Drawing No. 10

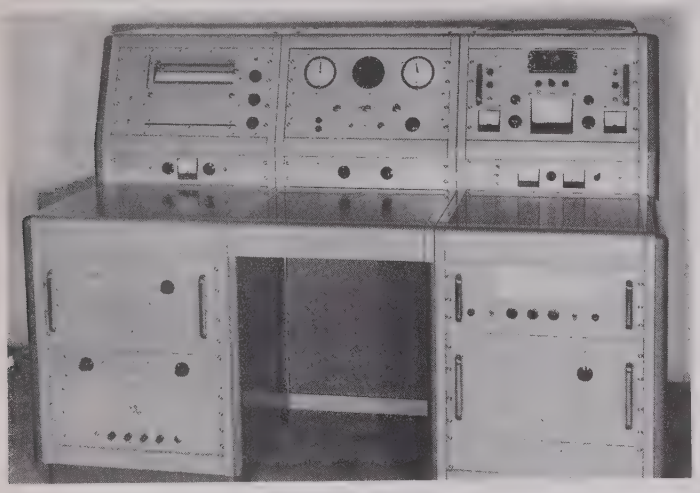
Wide Range Receiving System Carcinotron Power Supply Circuit Diagram

SCIENTIFIC–ATLANTA, INC.

2162 Piedmont Road, N.E.
ATLANTA 9, GEORGIA
TRinity 5-7291

60 db EXPANDED DYNAMIC RANGE SYSTEM

October, 1958



60 Db Combination Recorder and Receiver in Series 126 Console.

TECHNICAL DESCRIPTION

With the trend toward higher power radar and communication transmitters, the problem of investigating radiation in the minor lobes of antenna systems is becoming more and more acute, especially with today's more sensitive receivers and crowded spectrum conditions.

Heretofore, 40 db (input power) was considered to be the maximum linear dynamic range obtainable with conventional detectors and recorders. To investigate minor lobe radiation (or reception), the engineer was forced to use non-linear systems requiring frequent calibration checks, or make several patterns at different full scale references. These techniques were time consuming and subject to error.

Using a novel feedback arrangement between an S-A Pattern Recorder (either rectangular or polar) and an S-A Series 402 Receiver, an expanded dynamic range of at least 60 db can be realized. This is accomplished by introducing a bias voltage into the IF Amplifier of the receiver to change its gain as a function of the pen displacement of the recorder.

A special plug-in potentiometer (Scientific-Atlanta Model P-4) having an additional ganged section is required to generate the bias voltage. By use of taps and padding resistors on this section, the non-linear gain-vs-bias voltage characteristic of the IF Amplifier is automatically compensated to give an over-all linearity of ±1 db over the 60 db dynamic range.

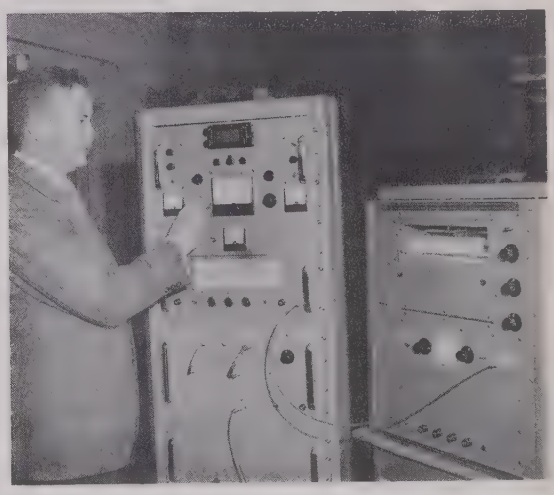
The modification includes the Model P-4 Potentiometer and modified IF chassis. No modifications are required to Scientific-Atlanta Series 121B or 122B Recorders. For existing receivers, the IF chassis must be returned to the factory for modification.

The user will have his choice of 40 or 60 db dynamic range by a switch installed on the IF chassis.

The S-A 60 db Expanded Dynamic Range System represents the latest development in antenna pattern recording techniques. This system takes advantage of the gain vs AGC voltage characteristic of the S-A Wide Range Receiver to add 20 db to the normal 40 db dynamic range of the conventional recorder.

FEATURES

- 1 db linearity over full 60 db dynamic range
- Plug-in potentiometer
- No modifications to S-A recorders required
- Available in console configuration or separate instruments.



60 db DYNAMIC RANGE SYSTEM

PRICES:

When specified at time of receiver order	$500.00
(Specify Modification P-4)	
For existing receivers*	$650.00
(Specify Modification P-4S)	
*Requires return of IF amplifier chassis to factory	
P-4 Replacement Potentiometer	$375.00
Special 60 db Paper, type 121-60, 40 yd. Roll	$ 3.75

SCIENTIFIC–ATLANTA, INC.

2162 Piedmont Road, N.E.
ATLANTA 9, GEORGIA
TRinity 5-7291

SERIES M
CRYSTAL MIXERS
1.7 — 75KMC

October, 1958

SERIES M CRYSTAL MIXERS

When the Series M Crystal Mixers are used with a Series 402 Receiver, the local oscillator signal from the receiver is fed to the mixer at the antenna terminal through a 50 ohm coaxial cable. The received signal heterodynes with the l-o signal or with one of its harmonics to produce an i-f signal which is proportional in amplitude to that of the received signal. The i-f signal is returned to the receiver through the same coaxial cable.

The crystal mixers may be located as far as 75 feet away from the receiver since only relatively low frequency signals are fed through the connecting cable. The receiver local oscillator has sufficient power to overcome the cable loss for the 2 to 4 kmc signal. The i-f signal is at 65 mc for which the loss is small.

Type RG-55/U double shielded cable is recommended for short connections between the receiver and crystal mixer. Type RG-5A/U cable is recommended for longer runs. Additional shielding may be required if the cable runs through strong radiation fields.

The crystal mixer used at frequencies below 2 kmc is located in the Series 402B and 402C Receivers. In this case the r-f signal is fed directly to the receiver through low-loss cable. The Model A-1.8 Waveguide to Coaxial Adaptor is used in the frequency range from 1.8 to 2.0 kmc in the case where the antenna has a waveguide feed.

The **S-A** Series M Crystal Mixers are designed to give continuous frequency coverage from 1.7 to 75 kmc. They are especially designed for use with the **S-A** Series 402 Wide Range Receiving System but may be used as crystal or bolometer mounts for simple video detection. Features include

- low capacity,
- standard waveguides and flanges,
- tunable shorts,
- BNC connectors,
- silver plating and baked enamel.

SPECIFICATIONS

Waveguide Crystal Mixers:

Model No.	Crystal*	Flange	Frequency Range KMC
M 1.8	IN21	UG-435/U	1.80 - 2.60
M 2.6	IN21	UG-214/U	2.60 - 3.95
M 3.9	IN21	UG-149/U	3.95 - 5.85
M 5.8	IN23	UG-344/U	5.85 - 8.20
M 8.2	IN23	UG- 39/U	8.20 - 12.4
M 12.4	IN78	UG-419/U	12.4 - 18.0
M 18.0	IN26	UG-425/U	18.0 - 26.5
M 26.5	IN53	UG-381/U	26.5 - 40.0
M 33	IN53	UG-383/U	33 - 50
M 50	IN53	UG-385/U	50 - 75
Coaxial Crystal Mixer:			
CM	IN1132	N to BNC	1.8 - 12.4
Waveguide to Coaxial Adaptor:			
A 1.8		UG-435/U	1.80 - 2.60

PRICES

M 1.8	Waveguide Crystal Mixer	$110.00
M 2.6	" " "	110.00
M 3.9	" " "	95.00
M 5.8	" " "	90.00
M 8.2	" " "	75.00
M 12.4	" " "	85.00
M 18.0	" " "	110.00
M 26.5	" " "	110.00
M 33	" " "	110.00
M 50	" " "	110.00
CM	Coaxial Crystal Mixer	70.00
A 1.8	Adaptor	80.00

*Crystals are not included. Later crystal versions will give improved sensitivity.

ALIGNMENT OF THE 60 DB SYSTEM

To align a Model 402 Receiver and a Model 121 or 122 Pattern Recorder with a Model P-4 Plug-in Potentiometer, the following steps are suggested:

1. Connect the cable between the receiver 60 db output connector (J1-9) and the recorder plug-in potentiometer, Model P-4.

2. Place the DYNAMIC RANGE switch (S1-9) in the 60 db position.

3. With a signal applied to the receiver input, adjust receiver controls (except RECEIVER GAIN) to obtain maximum recorder pen deflection as described in the instruction manual.

4. Turn PEN MOTOR OFF and manually position pen at 0 db (pen full scale).

5. With the maximum signal to be plotted applied to the receiver input, adjust RECEIVER GAIN control for if saturation as shown on the monitor oscilloscope. Reduce the RECEIVER GAIN setting for a peak signal level approximately 0.7 of the saturation level.

6. Turn PEN MOTOR ON and adjust recorder pen to 0 db line.

CALIBRATION OF THE 60 DB SYSTEM

To check and adjust the calibration of the 60 db system, a signal with a power level of at least 60 db above the minimum detectable signal and less than -10 dbm and a calibrated rf attenuator are required. The following steps are suggested:

1. With the signal fed through the rf attenuator (attenuator set for 0 db attenuation) to the receiver, align the 60 db system as suggested.

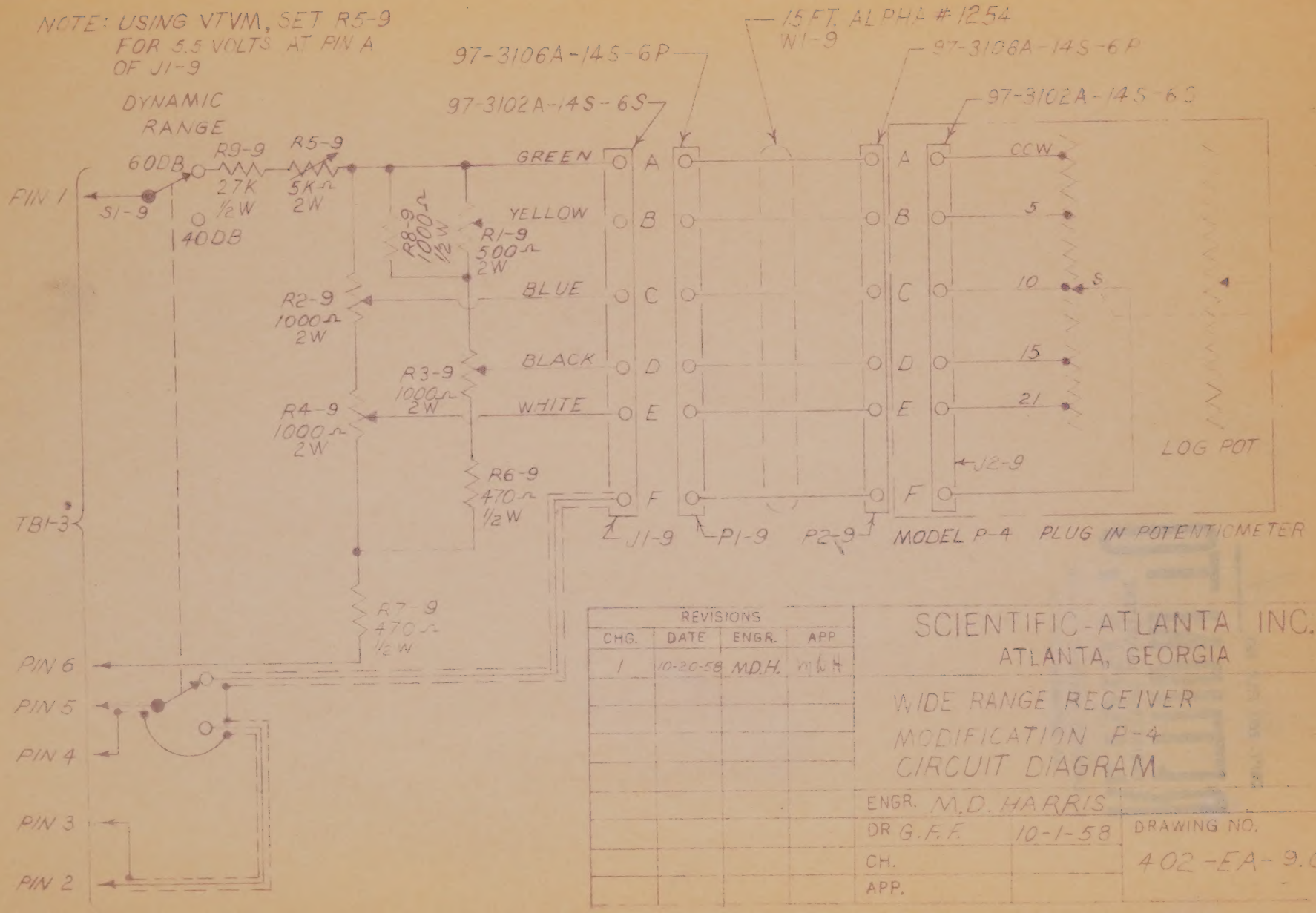
2. Set the rf attenuator for 15 db insertion loss and adjust R1-9 for 3/4 full scale (15 db) recorder pen deflection.

3. Set the rf attenuator for 30 db insertion loss and adjust R2-9 for 1/2 full scale (30 db) recorder pen deflection.

4. Set the rf attenuator for 45 db insertion loss and adjust R3-9 for 1/4 full scale (45 db) recorder pen deflection.

5. Set the rf attenuator for 60 db insertion loss and adjust R4-9 for zero (60 db) recorder pen deflection.

6. Repeat steps 2 through 5 until linearity of the system is within ±1 db.



REVISIONS			
CHG.	DATE	ENGR.	APP
1	10-20-58	M.D.H.	mdh

SCIENTIFIC-ATLANTA INC.
ATLANTA, GEORGIA

WIDE RANGE RECEIVER
MODIFICATION P-4
CIRCUIT DIAGRAM

ENGR. M.D. HARRIS
DR G.F.F. 10-1-58
CH.
APP.

DRAWING NO.
402-EA-9.0

DEPT. 260 FILE NO. 4

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